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Pocket Companion

containing

Useful Information and Tables

appertaining to the use of

Steel

as manufactured by

Carnegie Steel Company

Pittsburg, Pa.

For Engineers, Architects and Builders

1903

Price, $2.00

PREFACE

Edition of 1900. Revised 1903

The present edition includes most of the data of the 1896 ublication.

The safe transverse loads are now figured on the basis of 6,000 lbs. per square inch fiber stress for all rolled sections, nd 15,000 lbs. per square inch for riveted beam box and late girders.

New standard connecting angles for beams and channels ave been introduced; also additional tables of standards used n detailing.

All bolts for separators will be ¾ in. diameter, except hose for 3 in. beams.

The tables of properties of angles have been extended to nclude all thicknesses rolled, and new tables of safe loads for hannel columns have been added.

GENERAL NOTES

The flanges of both I-beams and standard channels ha now a uniform slope of 16⅔ per cent., being equivalent t inches per foot. The small fillets on I-beams and standa channels have been made to a radius of $\frac{6}{10}$ of the minimu web thickness; the large fillets to a radius of the minimu web thickness plus $\frac{1}{10}$ of an inch.

General (nearly straight line) formulæ have been adopt for both I-beams and standard channels to determine th dimensions and weights per foot, so that similar sections signed hereafter have their dimensions and weights alrea determined.

The manner in which the weight of the various sections increased is illustrated on page 25, Figs. 1, 2, 3 and 4.

For channels and I-beams the enlargement of the secti adds an equal amount to the thickness of web and the wid of the flanges.

The effect on angles of spreading the rolls is to sligh increase the length of the legs. Most of the sizes, howev are rolled in finishing grooves, whereby the exact dimensio are maintained for different thicknesses. Z-bars are increas in thickness in the same manner as angles.

I-beams and channels should be ordered to weights giv in the tables. Any weights ordered other than those sho in the tables will be furnished and charged for at the ne higher weight. Sections of shapes shown correspond only the minimum weight, excepting Z-bars.

Channels having but one weight specified can be roll only as shown. T-shapes do not admit of any variation a can be rolled only to the weight given.

All weights given are per lineal foot of the section.

A recapitulation of all rolled shapes is given on pages to 46 inclusive.

In ordering, designate weight or thickness wanted, b not both. Quicker deliveries can be obtained by orderi standard sections and weights.

All structural material will be cut to lengths with extre variation not exceeding ¼ of an inch, unless otherwise nged.

In calculating the areas and weights of the various sectio *ein shown the* fillets were disregarded except in special cas

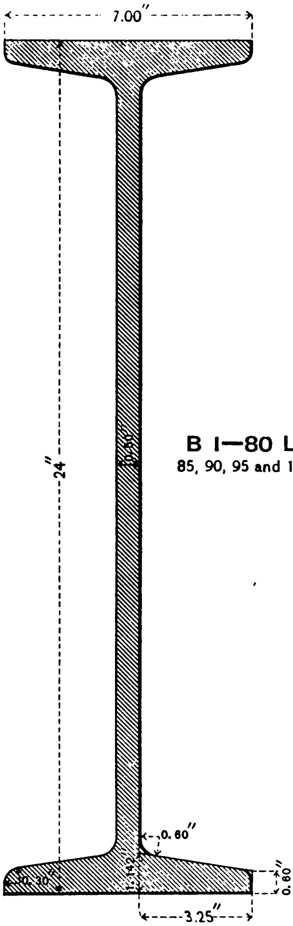
Shapes

Manufactured by

Carnegie Steel Company

Pittsburg, Pa.

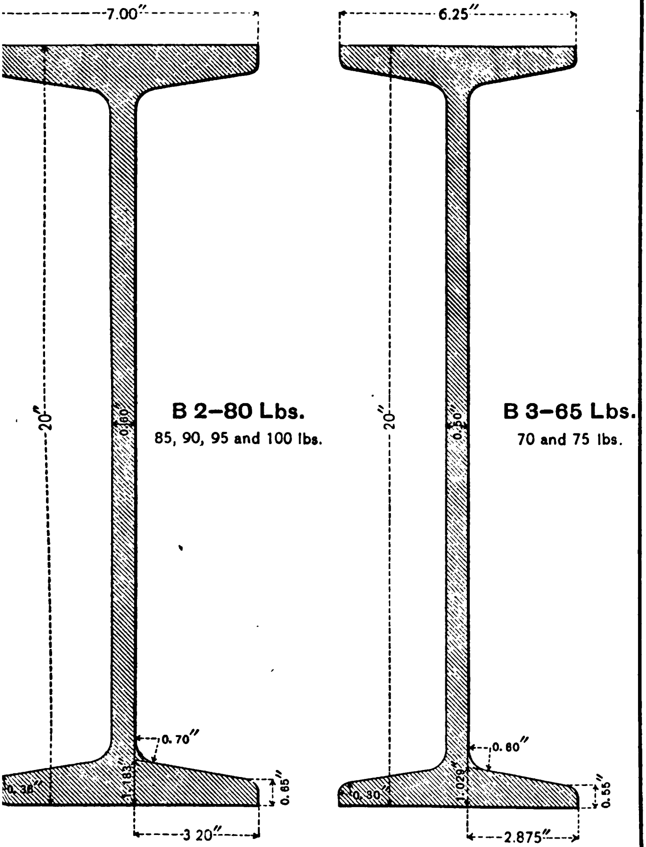
I-BEAMS



B 1—80 Lbs.
85, 90, 95 and 100 lbs.

***Weights* in heavy print are standard, others are spec**

I-BEAMS

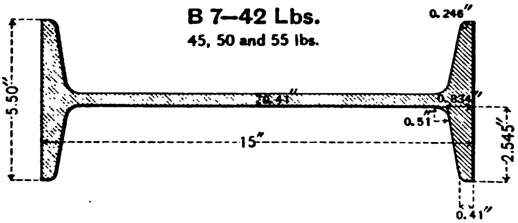


Weights in heavy print are standard, others are special.

I-BEAMS

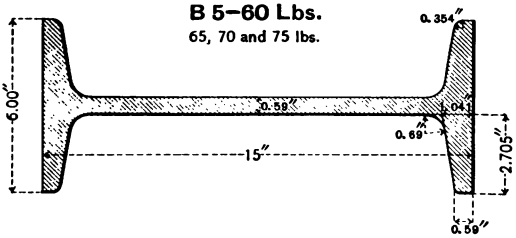
B 7—42 Lbs.

45, 50 and 55 lbs.



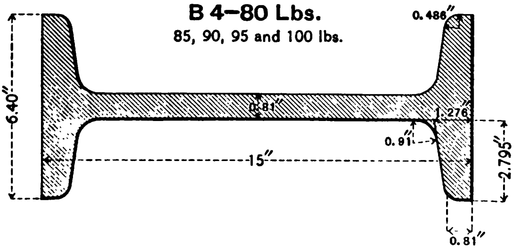
B 5—60 Lbs.

65, 70 and 75 lbs.



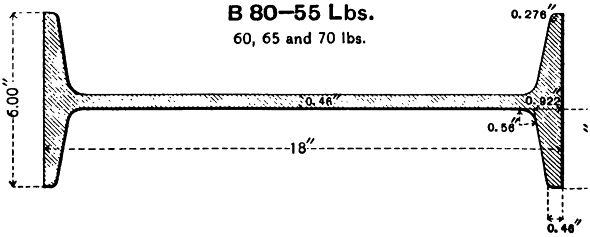
B 4—80 Lbs.

85, 90, 95 and 100 lbs.



B 80—55 Lbs.

60, 65 and 70 lbs.

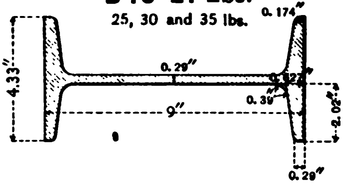


Weights in heavy print are standard, others are special.

I-BEAMS

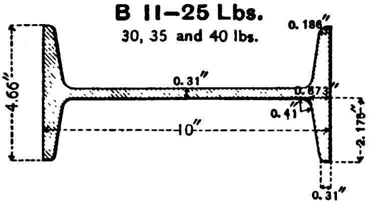
B 13–21 Lbs.

25, 30 and 35 lbs.



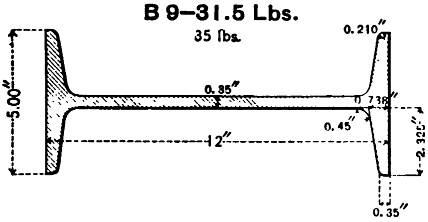
B 11–25 Lbs.

30, 35 and 40 lbs.



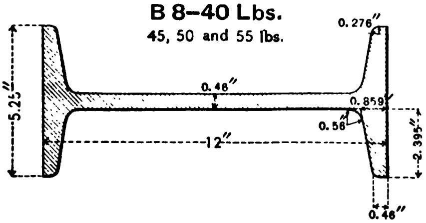
B 9–31.5 Lbs.

35 lbs.



B 8–40 Lbs.

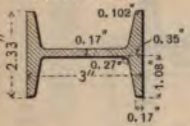
45, 50 and 55 lbs.



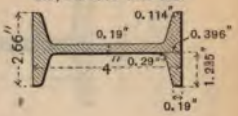
Weights in heavy print are standard, others are special.

I-BEAMS

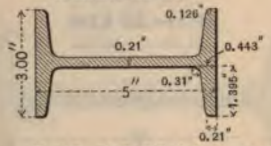
B 77—5.5 Lbs.
6.5 and 7.5 lbs.



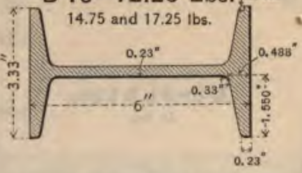
B 23—7.5 Lbs.
8.5, 9.5 and 10.5 lbs.



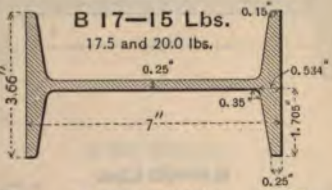
B 21—9.75 Lbs.
12.25 and 14.75 lbs.



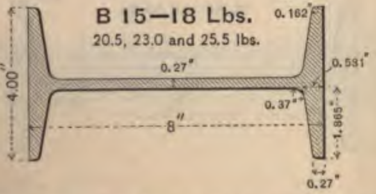
B 19—12.25 Lbs.
14.75 and 17.25 lbs.



B 17—15 Lbs.
17.5 and 20.0 lbs.



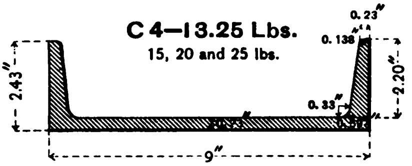
B 15—18 Lbs.
20.5, 23.0 and 25.5 lbs.



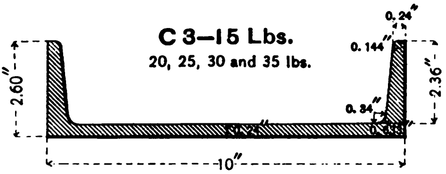
Weights in heavy print are standard, others are special.

CHANNELS

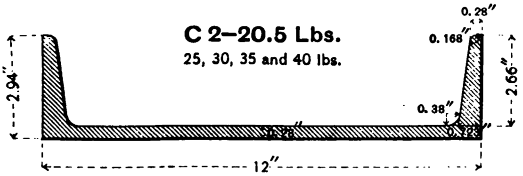
C 4—13.25 Lbs.
15, 20 and 25 lbs.



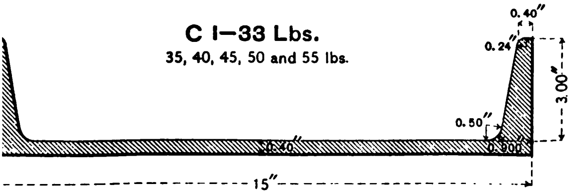
C 3—15 Lbs.
20, 25, 30 and 35 lbs.



C 2—20.5 Lbs.
25, 30, 35 and 40 lbs.



C 1—33 Lbs.
35, 40, 45, 50 and 55 lbs.

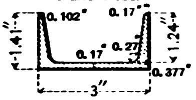


Weights in heavy print are standard, others are special.

CHANNELS

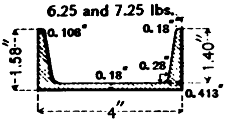
C 72—4 Lbs.

5 and 6 lbs.



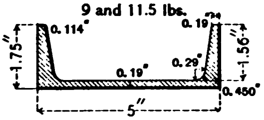
C 9—5.25 Lbs.

6.25 and 7.25 lbs.



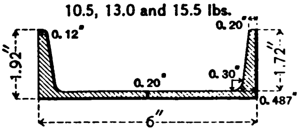
C 8—6.5 Lbs.

9 and 11.5 lbs.



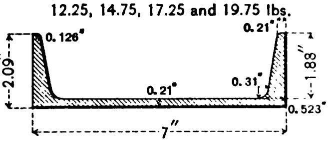
C 7—8 Lbs.

10.5, 13.0 and 15.5 lbs.



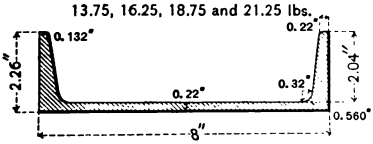
C 6—9.75 Lbs.

12.25, 14.75, 17.25 and 19.75 lbs.



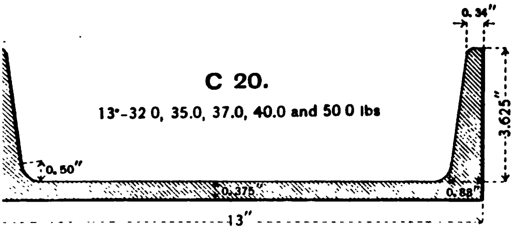
C 5—11.25 Lbs.

13.75, 16.25, 18.75 and 21.25 lbs.

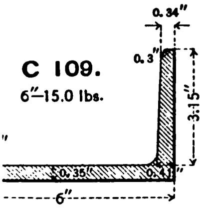


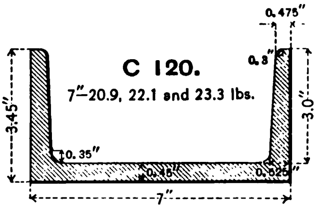
***Weights* in heavy print are standard, others are sp**

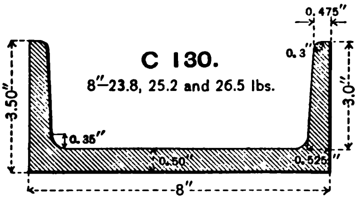
CAR-TRUCK CHANNELS

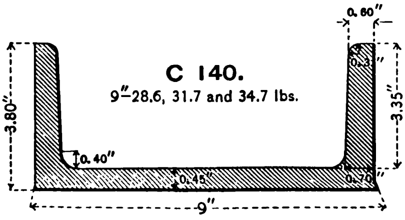


SHIP-BUILDING CHANNELS

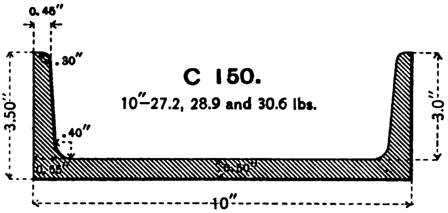


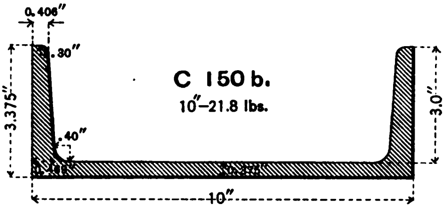




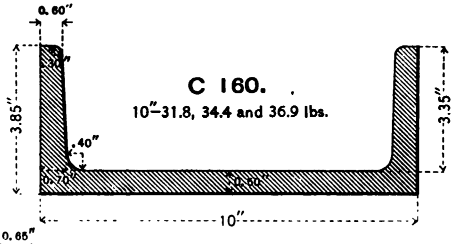


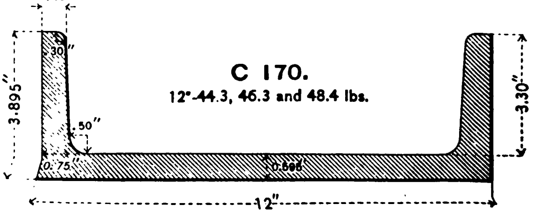
SHIP-BUILDING CHANNELS



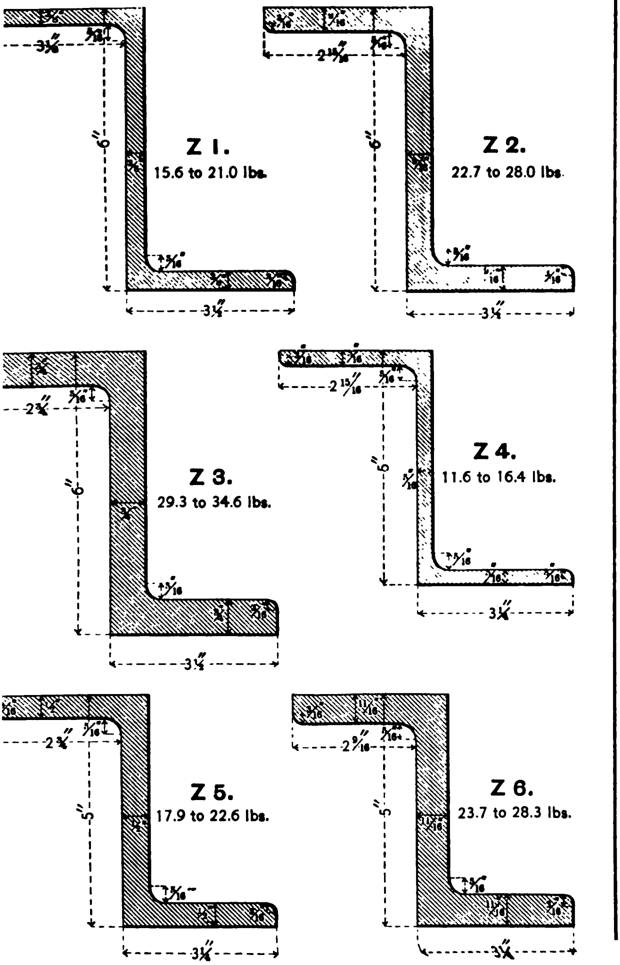


PROPOSED SHIP-BUILDING CHANNELS

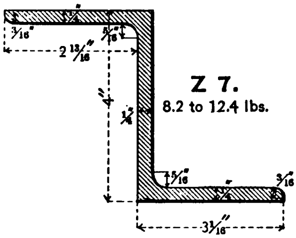




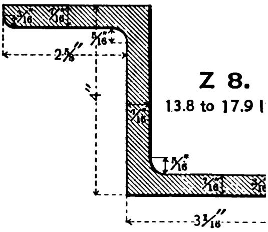
STANDARD Z-BARS



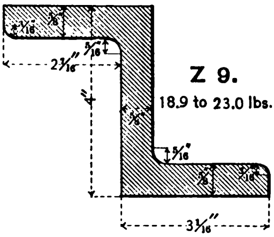
STANDARD Z-BARS



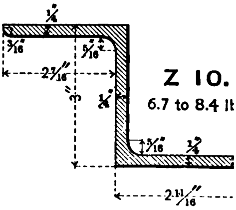
Z 7.
8.2 to 12.4 lbs.



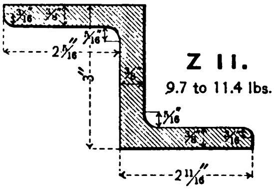
Z 8.
13.8 to 17.9 l



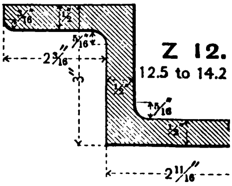
Z 9.
18.9 to 23.0 lbs.



Z 10.
6.7 to 8.4 lt

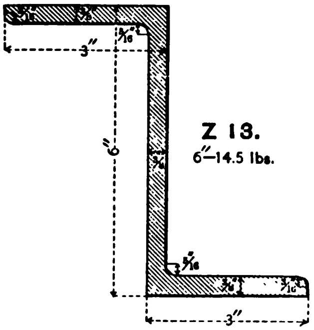


Z 11.
9.7 to 11.4 lbs.

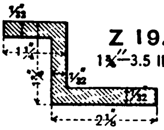


Z 12.
12.5 to 14.2

SPECIAL Z-BARS



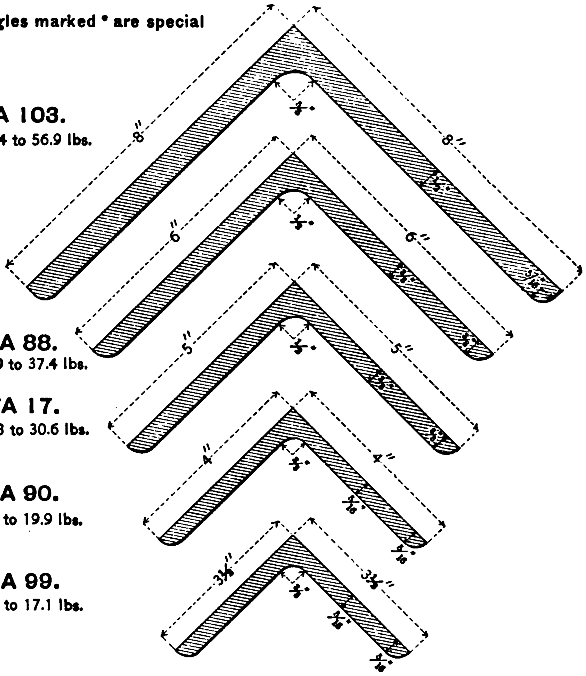
Z 13.
6"—14.5 lbs.



Z 19.
1⅜"—3.5 lbs.

ANGLES WITH EQUAL LEGS

Angles marked * are special



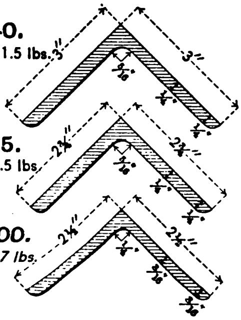
A 103.
26.4 to 56.9 lbs.

A 88.
14.9 to 37.4 lbs.

***A 17.**
12.3 to 30.6 lbs.

A 90.
8.2 to 19.9 lbs.

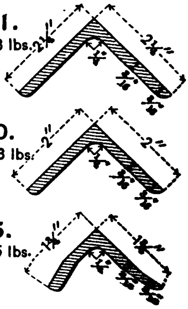
A 99.
7.2 to 17.1 lbs.



A 40.
4.9 to 11.5 lbs.

***A 45.**
4.5 to 8.5 lbs.

A 100.
3.1 to 7.7 lbs.



***A 101.**
2.8 to 6.8 lbs.

A 60.
2.5 to 5.3 lbs.

A 65.
2.2 to 4.6 lbs.

ANGLES WITH EQUAL LEGS

Angles marked * are special

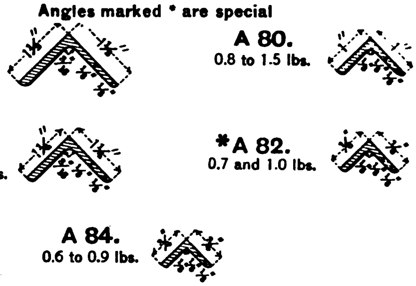
A 102.
1.3 to 3.4 lbs.

A 80.
0.8 to 1.5 lbs.

A 73.
1.1 to 2.4 lbs.

***A 82.**
0.7 and 1.0 lbs.

A 84.
0.6 to 0.9 lbs.



ANGLES WITH UNEQUAL LEGS

Angles marked * are special

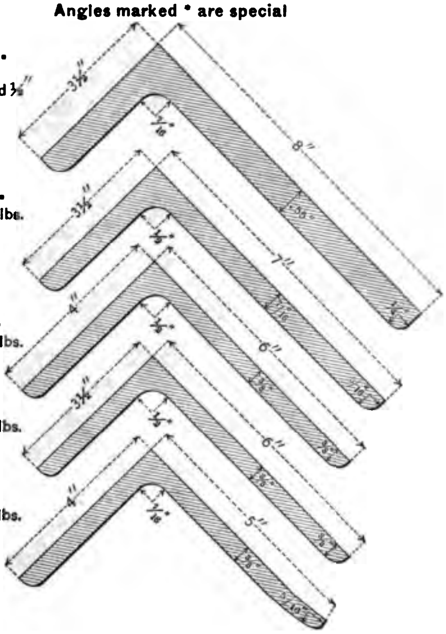
***A 140.**
20.5 lbs.
Can be rolled ½″

***A 159.**
15.0 to 32.3 lbs.

A 168.
12.3 to 30.6 lbs.

A 177.
11.7 to 28.9 lbs.

***A 186.**
11.0 to 24.2 lbs.



ANGLES WITH UNEQUAL LEGS

Angles marked * are special

A 96.
8.7 to 22.7 lbs.

A 280.
8.2 to 19.9 lbs.

***A 97.**
7.7 to 18.5 lbs.

***A 98.**
7.7 to 18.5 lbs.

A 228.
7.2 to 17.1 lbs.

A 237.
6.6 to 15.8 lbs.

A 245.
4.9 to 12.5 lbs.

***A 279.**
1.0 to 1.9 lbs.

***A 277.**
2.1 to 2.7 lbs.

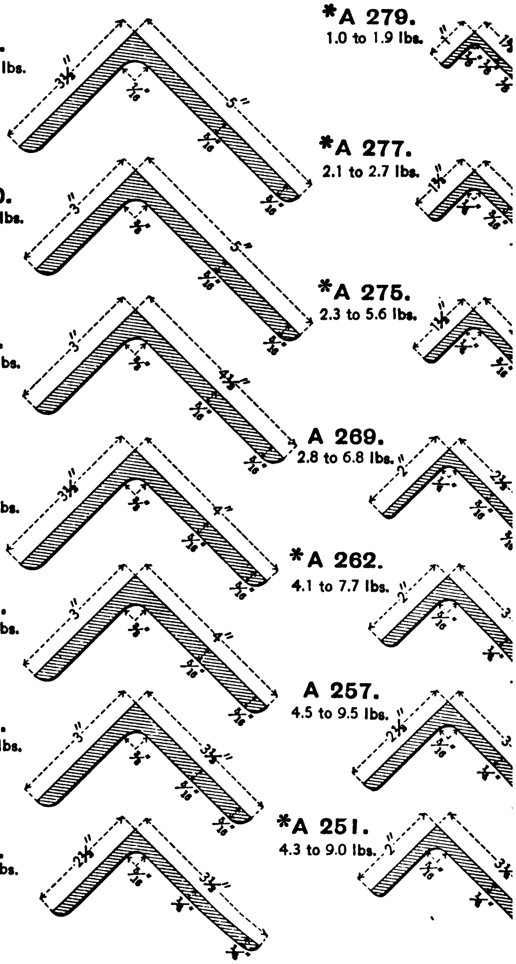
***A 275.**
2.3 to 5.6 lbs.

A 269.
2.8 to 6.8 lbs.

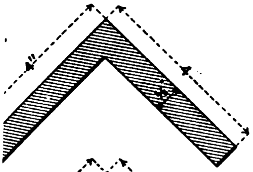
***A 262.**
4.1 to 7.7 lbs.

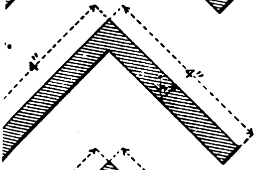
A 257.
4.5 to 9.5 lbs.

***A 251.**
4.3 to 9.0 lbs.



SPECIAL ANGLES—SQUARE ROOT





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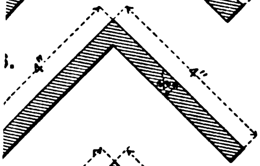

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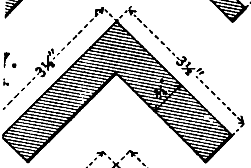

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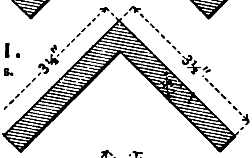
s.



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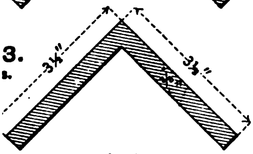
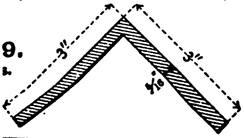
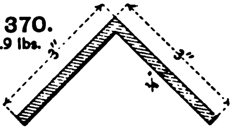


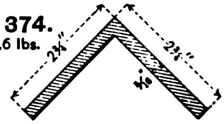
9.
s.



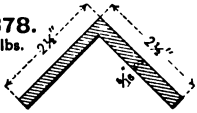
A 370.
4.9 lbs.



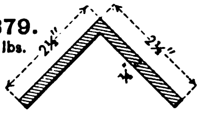
A 374.
5.6 lbs.



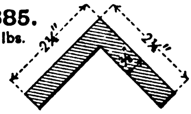
A 378.
5.0 lbs.



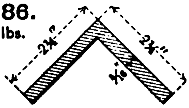
A 379.
4.1 lbs.



A 385.
5.3 lbs.



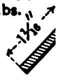
A 386.
4.5 lbs.



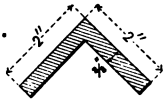
A 387.
3.7 lbs.

SPECIAL ANGLES—SQUARE ROOT

A 430.
1.1 lbs.



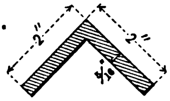
A 389.
4.7 lbs.



A 401.
2.0 lbs.

A 409.
1,5 lbs.

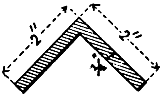
A 390.
4.0 lbs.



A 402.
1.5 lbs.

A 410.
1.2 lbs.

A 391.
3.2 lbs.



A 403.
1.1 lbs.

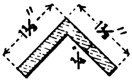
A 411.
0.8 lbs.

A 395.
2.8 lbs.

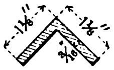
A 406.
1.7 lbs.

A 413.
0.7 lbs.

A 398.
2.4 lbs.



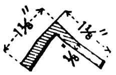
A 407.
1.3 lbs.



A 414.
0.9 lbs.

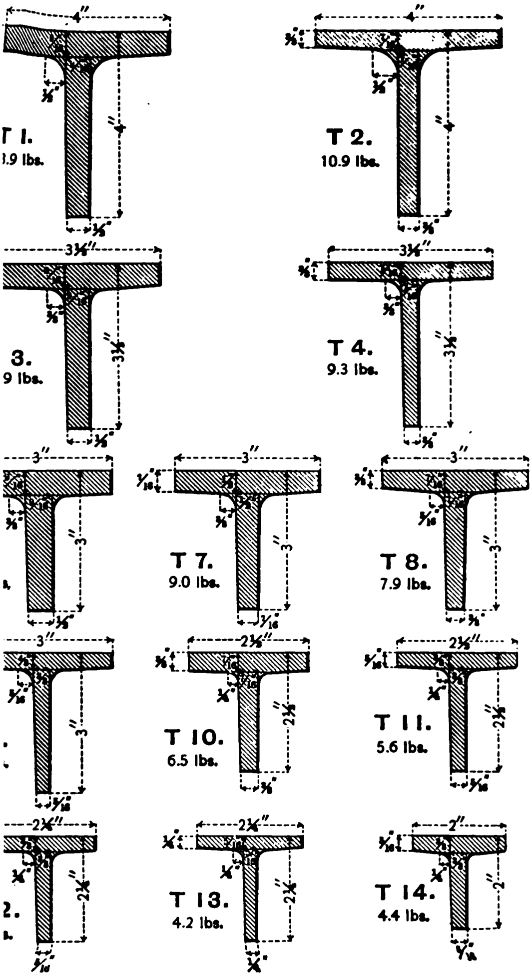
A 399.
1.8 lbs.

A 408.
0.9 lbs.



A 415.
0.6 lbs.

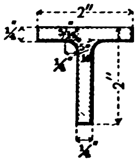
TEES WITH EQUAL LEGS



TEES WITH EQUAL LEGS

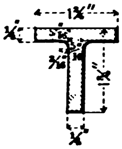
T 15.

3.7 lbs.



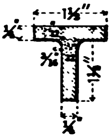
T 16.

3.2 lbs.



T 17.

2.6 lbs.

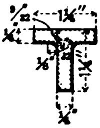


T 1

2.0 ll

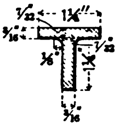
T 19.

2.1 lbs.



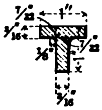
T 20.

1.7 lbs.



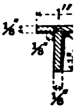
T 21.

1.3 lbs.



T 2

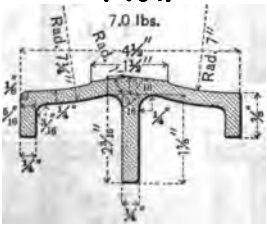
1.0 ll



HAND-RAIL TEES

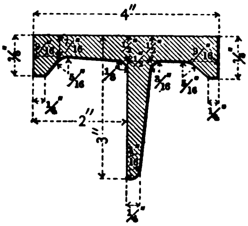
T 154.

7.0 lbs.

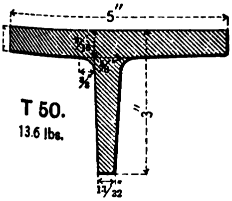


T 156.

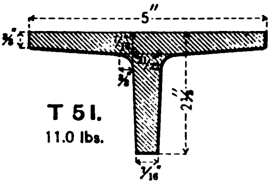
11.3 lbs.



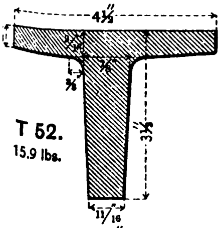
TEES WITH UNEQUAL LEGS



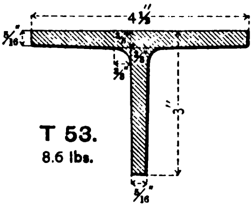
T 50.
13.6 lbs.



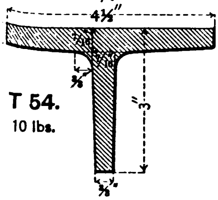
T 51.
11.0 lbs.



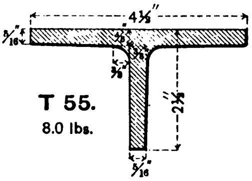
T 52.
15.9 lbs.



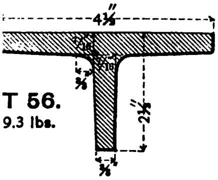
T 53.
8.6 lbs.



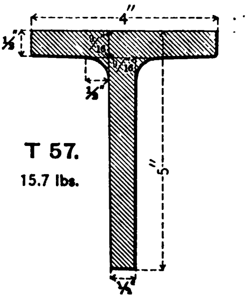
T 54.
10 lbs.



T 55.
8.0 lbs.

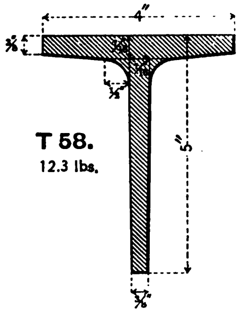


T 56.
9.3 lbs.

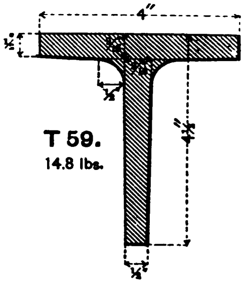


T 57.
15.7 lbs.

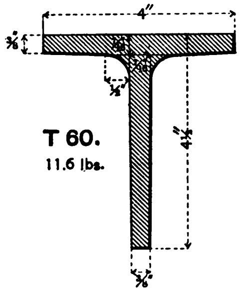
TEES WITH UNEQUAL LEGS



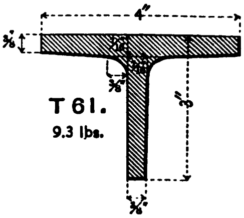
T 58.
12.3 lbs.



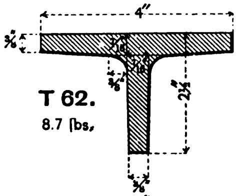
T 59.
14.8 lbs.



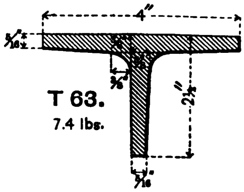
T 60.
11.6 lbs.



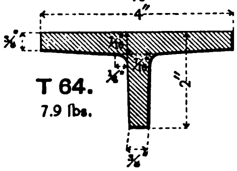
T 61.
9.3 lbs.



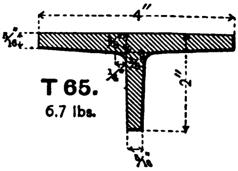
T 62.
8.7 lbs.



T 63.
7.4 lbs.

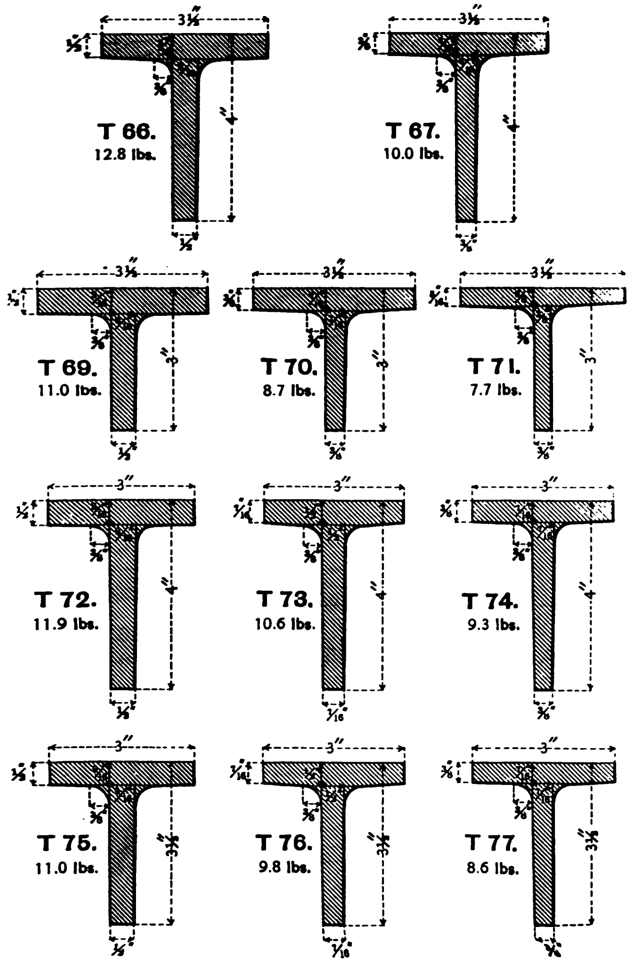


T 64.
7.9 lbs.

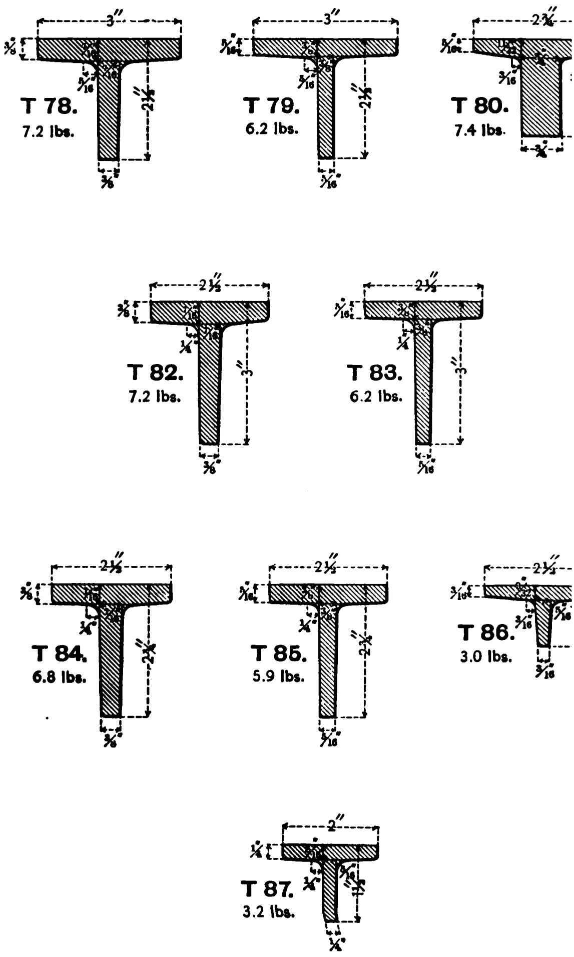


T 65.
6.7 lbs.

TEES WITH UNEQUAL LEGS



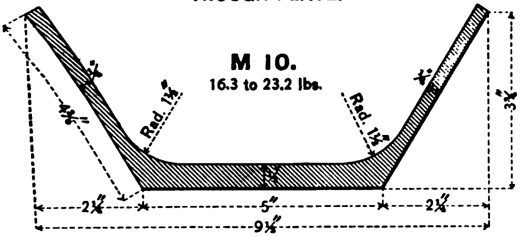
TEES WITH UNEQUAL LEGS



PLATES

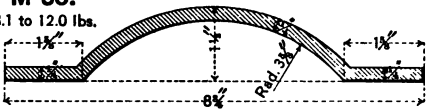
TROUGH PLATE.

M 10.
16.3 to 23.2 lbs.

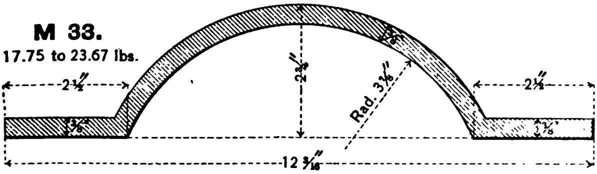


CORRUGATED PLATES.

M 30.
8.1 to 12.0 lbs.

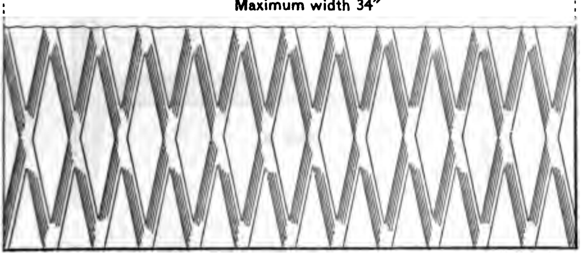


M 33.
17.75 to 23.67 lbs.



CHECKERED PLATE.

M 51.
Weight per sq. foot 13.8 to 21.4 lbs.
Maximum width 34"



5/16" to 1/2" Thick

METHOD OF INCREASING SECTIONAL AREA

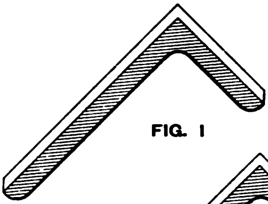


FIG. 1

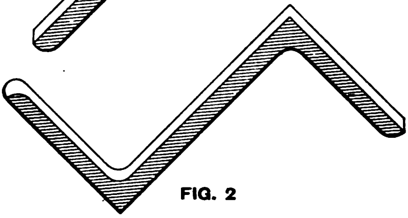


FIG. 2

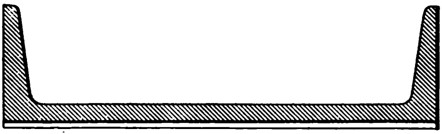


FIG. 3

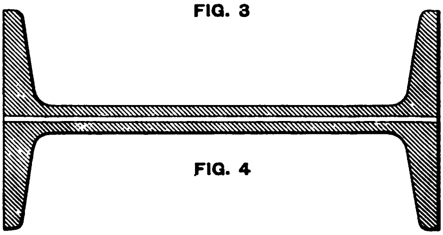


FIG. 4

DIMENSIONS AND WEIGHTS OF CARNEGIE BARS

ROUNDS

Size Inches	Weight per Foot Pounds	Size Inches	Weight per Foot Pounds	Size Inches	Weight per Foot Pounds	Size Inches
1/4	.17	11/16	1.26	1 1/4	4.17	3
9/32	.21	23/32	1.38	1 5/16	4.60	3 1/8
5/16	.26	47/64	1.44	1 3/8	5.05	3 1/4
11/32	.32	3/4	1.50	1 7/16	5.52	3 3/8
23/64	.35	25/32	1.63	1 15/32	5.77	3 1/2
3/8	.38	13/16	1.76	1 1/2	6.01	3 5/8
25/64	.41	53/64	1.84	1 9/16	6.52	3 3/4
13/32	.44	27/32	1.91	1 5/8	7.05	3 7/8
7/16	.51	55/64	1.97	1 11/16	7.60	4
29/64	.55	7/8	2.04	1 3/4	8.18	4 1/4
15/32	.59	29/32	2.19	1 13/16	8.77	4 1/2
31/64	.63	15/16	2.35	1 7/8	9.39	4 3/4
1/2	.67	31/32	2.51	1 15/16	10.02	5
33/64	.71	63/64	2.59	2	10.68	5 1/4
17/32	.75	1	2.67	2 1/8	12.06	5 1/2
35/64	.80	1 1/32	2.84	2 1/4	13.52	5 3/4
9/16	.85	1 1/16	3.01	2 3/8	15.07	6
19/32	.94	1 3/32	3.19	2 1/2	16.69	6 1/4
39/64	.99	1 7/64	3.28	2 5/8	18.40	6 1/2
5/8	1.04	1 1/8	3.38	2 3/4	20.20	6 3/4
21/32	1.15	1 3/16	3.77	2 7/8	22.07	

SQUARES

Size Inches	Weight per Foot Pounds	Size Inches	Weight per Foot Pounds	Size Inches	Weight per Foot Pounds	Size Inches
1/4	.21	7/8	2.60	1 1/2	7.65	2 1/4
5/16	.33	15/16	2.99	1 9/16	8.30	2 1/2
3/8	.48	1	3.40	1 5/8	8.98	2 3/4
7/16	.65	1 1/16	3.84	1 11/16	9.68	3
1/2	.85	1 1/8	4.30	1 3/4	10.41	3 1/4
9/16	1.08	1 3/16	4.80	1 13/16	11.17	3 1/2
5/8	1.33	1 1/4	5.31	1 7/8	11.95	3 3/4
11/16	1.61	1 5/16	5.86	1 15/16	12.76	4
3/4	1.91	1 3/8	6.43	2	13.60	4 1/2
13/16	2.25	1 7/16	7.03	2 1/8	15.35	5

DIMENSIONS AND WEIGHTS OF CARNEGIE BARS—Continued

FLATS

Thickness Inches	Minimum Wt. per Foot, Pounds	Width Inches	Thickness Inches	Minimum Wt. per Foot, Pounds
$\frac{3}{16}$ to $\frac{5}{8}$	.40	$3\frac{5}{8}$	$\frac{3}{16}$ to $1\frac{1}{2}$	2.31
$\frac{3}{16}$ to $\frac{3}{4}$	.48	$3\frac{3}{4}$	$\frac{3}{16}$ to $1\frac{1}{2}$	2.39
$\frac{3}{16}$ to $\frac{7}{8}$	.56	4	$\frac{3}{16}$ to $1\frac{3}{4}$	2.55
$\frac{3}{16}$ to $\frac{7}{8}$	.64	$4\frac{1}{8}$	$\frac{3}{16}$ to $1\frac{1}{2}$	2.63
$\frac{3}{16}$ to $\frac{7}{8}$	.72	$4\frac{1}{4}$	$\frac{3}{16}$ to $1\frac{1}{2}$	2.71
$\frac{3}{16}$ to $\frac{7}{8}$	.80	$4\frac{3}{8}$	$\frac{3}{16}$ to $1\frac{1}{2}$	2.79
$\frac{3}{16}$ to $\frac{7}{8}$	.88	$4\frac{1}{2}$	$\frac{3}{16}$ to $1\frac{1}{2}$	2.87
$\frac{3}{16}$ to 1	.96	$4\frac{5}{8}$	$\frac{3}{16}$ to $1\frac{1}{2}$	2.95
$\frac{3}{16}$ to 1	1.03	$4\frac{3}{4}$	$\frac{3}{16}$ to $1\frac{1}{2}$	3.03
$\frac{3}{16}$ to 1	1.11	$4\frac{7}{8}$	$\frac{3}{16}$ to $1\frac{1}{2}$	3.11
$\frac{3}{16}$ to 1	1.20	5	$\frac{3}{16}$ to $2\frac{1}{4}$	3.19
$\frac{3}{16}$ to 1	1.28	$5\frac{1}{8}$	$\frac{3}{16}$ to $1\frac{1}{2}$	3.27
$\frac{3}{16}$ to 1	1.44	$5\frac{1}{4}$	$\frac{3}{16}$ to $1\frac{1}{2}$	3.35
$\frac{3}{16}$ to 1	1.51	$5\frac{3}{8}$	$\frac{3}{16}$ to $1\frac{1}{2}$	3.43
$\frac{3}{16}$ to 1	1.59	$5\frac{1}{2}$	$\frac{3}{16}$ to $1\frac{1}{2}$	3.51
$\frac{3}{16}$ to 1	1.67	$5\frac{5}{8}$	$\frac{3}{16}$ to $1\frac{1}{2}$	3.59
$\frac{3}{16}$ to 1	1.75	$5\frac{3}{4}$	$\frac{3}{16}$ to $1\frac{1}{2}$	3.67
$\frac{3}{16}$ to $1\frac{3}{4}$	1.91	$5\frac{7}{8}$	$\frac{3}{16}$ to $1\frac{1}{2}$	3.75
$\frac{3}{16}$ to $1\frac{3}{4}$	1.99	6	$\frac{3}{16}$ to $2\frac{1}{4}$	3.83
$\frac{3}{16}$ to $1\frac{3}{4}$	2.07	7	$\frac{3}{16}$ to $2\frac{1}{4}$	4.46
$\frac{3}{16}$ to $1\frac{3}{4}$	2.15	8	$\frac{3}{16}$ to $2\frac{1}{4}$	5.10
$\frac{3}{16}$ to $1\frac{3}{4}$	2.23			

HALF ROUNDS

$\frac{3}{2}$, $\frac{7}{16}$, $\frac{29}{64}$, $\frac{15}{32}$, $\frac{1}{2}$, $\frac{33}{64}$, $\frac{17}{32}$, $\frac{9}{16}$, $\frac{19}{32}$, $\frac{5}{8}$, $\frac{21}{32}$, $\frac{11}{16}$,
$\frac{5}{2}$, $\frac{13}{16}$, $\frac{27}{32}$, $\frac{7}{8}$, $\frac{29}{32}$, $\frac{15}{16}$, 1, $1\frac{1}{32}$, $1\frac{1}{8}$, $1\frac{1}{4}$, $1\frac{3}{8}$, $1\frac{1}{2}$,
$1\frac{3}{4}$, 2, $2\frac{1}{2}$, 3

ghts take half of those for corresponding rounds

OVALS

Weight er Foot Pounds	Size Inches	Weight per Foot Pounds	Size Inches	Weight per Foot Pounds	Size Inches	Weight per Foot Pounds
1.50	$\frac{7}{8} \times \frac{5}{16}$	.78	$\frac{19}{32} \times \frac{9}{32}$	.42	$\frac{1}{2} \times \frac{3}{8}$	.50
1.20	$\frac{3}{4} \times \frac{3}{8}$	.75	$\frac{9}{16} \times \frac{3}{8}$	.507	$\frac{5}{8} \times \frac{5}{16}$	.50
.90	$\frac{3}{4} \times \frac{5}{16}$	*.60*	$\frac{17}{32} \times \frac{9}{32}$	.36		

DIMENSIONS AND WEIGHTS OF CARNEGIE BARS—Continued

FLAT OVALS

Size Inches	Weight per Foot Pounds	Size Inches	Weight per Foot Pounds	Size Inches	[illegible]
1¾ x 1	5.22	1⅞ x 1	5.65	2 x 1	[illegible]
1¾ x 1⅛	6.18	1⅞ x 1⅛	6.44	2 x 1⅛	[illegible]
1¾ x 1¼	7.14	1⅞ x 1¼	7.24	2 x 1⅜	[illegible]

ROUND OVALS

Size Inches	Weight per Foot Pounds	Size Inches	Weight per Foot Pounds
2 x 1½	8.01	2 3/16 x 1 9/16	9.1[illegible]

ROUND EDGE FLATS

Size Inches	Weight per Foot Pounds	Size Inches	Weight per Foot Pounds	Size Inches	Weight per Foot Pounds	Size Inches	[illegible]
1 x 3/16	.61	1¾ x 7/16	2.46	2¼ x 7/16	3.21	2¾ x 7/16	[illegible]
1 x ¼	.81	1¾ x ½	2.79	2¼ x ½	3.65	2¾ x ½	[illegible]
1 x 5/16	.99	1¾ x 9/16	3.11	2¼ x 9/16	4.07	2¾ x 9/16	[illegible]
1 x ⅜	1.16	1¾ x ⅝	3.43	2¼ x ⅝	4.50	2¾ x ⅝	[illegible]
1 x 7/16	1.35	1¾ x 11/16	3.74	2¼ x 11/16	4.92	2¾ x 11/16	[illegible]
1¼ x 3/16	.77	1¾ x ¾	4.05	2¼ x ¾	5.33	2¾ x ¾	[illegible]
1¼ x ¼	1.02	1¾ x 13/16	4.35	2¼ x 13/16	5.74	2¾ x 13/16	[illegible]
1¼ x 5/16	1.25	1¾ x ⅞	4.65	2¼ x ⅞	6.14	2¾ x ⅞	[illegible]
1¼ x ⅜	1.49	1¾ x 15/16	4.94	2¼ x 15/16	6.53	2¾ x 15/16	[illegible]
1¼ x 7/16	1.71	1¾ x 1	5.23	2¼ x 1	6.92	2¾ x 1	[illegible]
1½ x ¼	1.23	2 x ¼	1.66	2½ x ¼	2.08	3 x ¼	[illegible]
1½ x 5/16	1.52	2 x 5/16	2.04	2½ x 5/16	2.58	3 x 5/16	[illegible]
1½ x ⅜	1.81	2 x ⅜	2.45	2½ x ⅜	3.08	3 x ⅜	[illegible]
1½ x 7/16	2.09	2 x 7/16	2.83	2½ x 7/16	3.58	3 x 7/16	[illegible]
1½ x ½	2.37	2 x ½	3.22	2½ x ½	4.07	3 x ½	[illegible]
1½ x 9/16	2.64	2 x 9/16	3.59	2½ x 9/16	4.55	3 x 9/16	[illegible]
1½ x ⅝	2.90	2 x ⅝	3.96	2½ x ⅝	5.02	3 x ⅝	[illegible]
1½ x 11/16	3.16	2 x 11/16	4.32	2½ x 11/16	5.49	3 x 11/16	[illegible]
1½ x ¾	3.41	2 x ¾	4.69	2½ x ¾	5.97	3 x ¾	[illegible]
1½ x 13/16	3.65	2 x 13/16	5.04	2½ x 13/16	6.42	3 x 13/16	[illegible]
1½ x ⅞	3.90	2 x ⅞	5.39	2½ x ⅞	6.87	3 x ⅞	[illegible]
1½ x 15/16	4.14	2 x 15/16	5.73	2½ x 15/16	7.32	3 x 15/16	[illegible]
1½ x 1	4.37	2 x 1	6.07	2½ x 1	7.77	3 x 1	[illegible]
1¾ x ¼	1.45	2¼ x ¼	1.87	2¾ x ¼	2.29	....	
1¾ x 5/16	1.79	2¼ x 5/16	2.31	2¾ x 5/16	2.84	....	
¾ x ⅜	2.13	2¼ x ⅜	2.76	2¾ x ⅜	3.40	....	

LIST OF EXTREME SIZES OF RECTANGULA STEEL SHEETS 3/16 IN. AND LIGHTER ROLLED BY CARNEGIE STEEL COMPANY

Thickness	68 Inch Width	66 Inch Width	64 Inch Width	62 Inch Width	60 Inch Width	58 Inch Width	56 Inch Width
3/16	160	180	180	192	216	228	240
No. 8, B.W.G.	160	180	180	182	186	190	196
" 9, "	....	160	160	166	172	184	190
" 10, "	....	140	145	155	160	168	176
" 11, "	....	120	130	140	150	155	165
" 12, "	....	108	115	124	130	140	150

Thickness	52 Inch Width	50 Inch Width	48 Inch Width	44 Inch Width	40 Inch Width	36 Inch Width	24 Inch Width
3/16	264	288	300	316	360	360	360
No. 8, B.W.G.	212	224	240	240	264	264	264
" 9, "	212	220	224	236	248	248	248
" 10, "	196	200	212	212	212	212	212
" 11, "	180	186	192	196	200	200	200
" 12, "	170	176	180	180	180	180	180

LIST OF EXTREME SIZES OF CIRCULAR PLATES ROLLED BY CARNEGIE STEEL COMPANY

Thickness in Inches	Diameter in Inches	Thickness in Inches	Diameter in Inches
1/4	102	3/4	120
5/16	108	13/16	120
3/8	110	7/8	120
7/16	115	1	120
1/2	115	1 1/8	112
9/16	115	1 1/4	112
5/8	120	1 1/2	112
11/16	120		

MINIMUM, MAXIMUM AND INTERMEDIATE WEIGHTS AND DIMENSIONS OF I-BEAMS

Section Index	Depth of Beam Inches	Weight per Foot Pounds	Flange Width: Inches and Decimal Parts	Flange Width: Inches and Fractional Parts	Web Thickness: Decimal Parts of Inch	Web Thickness: Fractional Parts of Inch	Page No. of Section
B 1	24	100.00	7.254	7 1/4	.754	3/4	1
		95.00	7.192	7 3/16	.692	11/16	
		90.00	7.131	7 1/8	.631	5/8	
		85.00	7.070	7 1/16	.570	9/16	
		80.00	**7.000**	**7**	**.500**	**1/2**	
B 2	20	100.00	7.284	7 9/32	.884	7/8	2
		95.00	7.210	7 13/64	.810	13/16	
		90.00	7.187	7 3/16	.737	47/64	
		85.00	7.063	7 1/16	.663	21/32	
		80.00	**7.000**	**7**	**.600**	19/32	
B 3	20	75.00	6.399	6 13/32	.649	21/32	2
		70.00	6.325	6 21/64	.575	37/64	
		65.00	**6.250**	**6 1/4**	**.500**	**1/2**	
B 80	18	70.00	6.259	6 17/64	.719	23/32	3
		65.00	6.177	6 11/64	.637	5/8	
		60.00	6.095	6 3/32	.555	35/64	
		55.00	**6.000**	**6**	**.460**	29/64	
B 4	15	100.00	6.774	6 25/32	1.184	1 3/16	3
		95.00	6.675	6 43/64	1.085	1 5/64	
		90.00	6.577	6 37/64	.987	63/64	
		85.00	6.479	6 31/64	.889	57/64	
		80.00	**6.400**	**6 13/32**	**.810**	13/16	
B 5	15	75.00	6.292	6 19/64	.882	57/64	3
		70.00	6.194	6 3/16	.784	25/32	
		65.00	6.096	6 3/32	.686	11/16	
		60.00	**6.000**	**6**	**.590**	19/32	
B 7	15	55.00	5.746	5 3/4	.656	21/32	3
		50.00	5.648	5 41/64	.558	35/64	
		45.00	5.550	5 35/64	.460	29/64	
		42.00	**5.500**	**5 1/2**	**.410**	13/32	
B 8	12	55.00	5.612	5 39/64	.822	13/16	4
		50.00	5.489	5 31/64	.699	11/16	
		45.00	5.366	5 23/64	.576	9/16	
		40.00	**5.250**	**5 1/4**	**.460**	29/64	

Weights in **heavy print are standard, others are special**

MINIMUM, MAXIMUM AND INTERMEDIAT
WEIGHTS AND DIMENSIONS OF
I-BEAMS—Continued

Section Index	Depth of Beam Inches	Weight per Foot Pounds	Flange Width		Web Thickness	
			Inches and Decimal Parts	Inches and Fractional Parts	Decimal Parts of Inch	Fractional Parts of Inch
B 9	12	35.00	5.086	$5\frac{3}{32}$	.436	$\frac{7}{16}$
		31.50	**5.000**	**5**	**.350**	$\frac{11}{32}$
B 11	10	40.00	5.099	$5\frac{3}{32}$	.749	$\frac{3}{4}$
		35.00	4.952	$4\frac{61}{64}$	.602	$\frac{39}{64}$
		30.00	4.805	$4\frac{13}{16}$	.455	$\frac{15}{32}$
		25.00	**4.660**	$4\frac{21}{32}$	**.310**	$\frac{5}{16}$
B 13	9	35.00	4.772	$4\frac{49}{64}$	.732	$\frac{47}{64}$
		30.00	4.609	$4\frac{39}{64}$	.569	$\frac{37}{64}$
		25.00	4.446	$4\frac{29}{64}$	.406	$\frac{27}{64}$
		21.00	**4.330**	$4\frac{21}{64}$	**.290**	$\frac{19}{64}$
B 15	8	25.50	4.271	$4\frac{17}{64}$	.541	$\frac{17}{32}$
		23.00	4.179	$4\frac{11}{64}$	.449	$\frac{7}{16}$
		20.50	4.087	$4\frac{3}{32}$	.357	$\frac{23}{64}$
		18.00	**4.000**	**4**	**.270**	$\frac{17}{64}$
B 17	7	20.00	3.868	$3\frac{7}{8}$	.458	$\frac{15}{32}$
		17.50	3.763	$3\frac{49}{64}$	.353	$\frac{23}{64}$
		15.00	**3.660**	$3\frac{21}{32}$	**.250**	$\frac{1}{4}$
B 19	6	17.25	3.575	$3\frac{37}{64}$	.475	$\frac{31}{64}$
		14.75	3.452	$3\frac{29}{64}$	.352	$\frac{23}{64}$
		12.25	**3.330**	$3\frac{21}{64}$	**.230**	$\frac{15}{64}$
B 21	5	14.75	3.294	$3\frac{19}{64}$	.504	$\frac{1}{2}$
		12.25	3.147	$3\frac{9}{64}$	.357	$\frac{23}{64}$
		9.75	**3.000**	**3**	**.210**	$\frac{13}{64}$
B 23	4	10.50	2.880	$2\frac{7}{8}$	.410	$\frac{13}{32}$
		9.50	2.807	$2\frac{13}{16}$	.337	$\frac{11}{32}$
		8.50	2.733	$2\frac{47}{64}$	.263	$\frac{17}{64}$
		7.50	**2.660**	$2\frac{21}{32}$	**.190**	$\frac{3}{16}$
B 77	3	7.50	2.521	$2\frac{33}{64}$	.361	$\frac{23}{64}$
		6.50	2.423	$2\frac{27}{64}$	.263	$\frac{17}{64}$
		5.50	**2.330**	$2\frac{21}{64}$	**.170**	$\frac{11}{64}$

…ts in heavy print are standard; others are special

MINIMUM, MAXIMUM AND INTERMEDIATE WEIGHTS AND DIMENSIONS OF CHANNELS

Section Index	Depth of Channel Inches	Weight per Foot Pounds	Flange Width		Web Thickness		Page No. of Section
			Inches and Decimal Parts	Inches and Fractional Parts	Decimal Parts of Inch	Fractional Parts of Inch	
C1	15	55.00	3.818	3 13/16	.818	13/16	6
		50.00	3.720	3 23/32	.720	23/32	
		45.00	3.622	3 5/8	.622	5/8	
		40.00	3.524	3 17/32	.524	17/32	
		35.00	3.426	3 27/64	.426	27/64	
		33.00	**3.400**	**3 13/32**	**.400**	13/32	
C2	12	40.00	3.418	3 27/64	.758	49/64	6
		35.00	3.296	3 19/64	.636	41/64	
		30.00	3.173	3 11/64	.513	33/64	
		25.00	3.050	3 3/64	.390	25/64	
		20.50	**2.940**	**2 15/16**	**.280**	9/32	
C3	10	35.00	3.183	3 3/16	.823	53/64	6
		30.00	3.036	3 1/32	.676	43/64	
		25.00	2.889	2 57/64	.529	17/32	
		20.00	2.742	2 47/64	.382	3/8	
		15.00	**2.600**	**2 19/32**	**.240**	15/64	
C4	9	25.00	2.815	2 13/16	.615	39/64	6
		20.00	2.652	2 21/32	.452	29/64	
		15.00	2.488	2 31/64	.288	9/32	
		13.25	**2.430**	**2 7/16**	**.230**	15/64	
C5	8	21.25	2.622	2 5/8	.582	37/64	7
		18.75	2.530	2 17/32	.490	31/64	
		16.25	2.439	2 7/16	.399	25/64	
		13.75	2.347	2 11/32	.307	19/64	
		11.25	**2.260**	**2 17/64**	**.220**	7/32	
6	7	19.75	2.513	2 33/64	.633	5/8	7
		17.25	2.408	2 13/32	.528	33/64	
		14.75	2.303	2 19/64	.423	13/32	
		12.25	2.198	2 13/64	.318	5/16	
		9.75	**2.090**	**2 3/32**	**.210**	13/64	
7	6	15.50	2.283	2 9/32	.563	9/16	7
		13.00	2.160	2 5/32	.440	7/16	
		10.50	2.038	2 1/32	.318	5/16	
		8.00	**1.920**	**1 59/64**	**.200**	13/64	
8	5	11.50	2.037	2 1/32	.477	15/32	7
		9.00	1.890	1 57/64	.330	21/64	
		6.50	**1.750**	**1 3/4**	**.190**	3/16	
9	4	7.25	1.725	1 23/32	.325	21/64	7
		6.25	1.652	1 21/32	.252	17/64	
		5.25	**1.580**	**1 37/64**	**.180**	3/16	
72	3	6.00	1.602	1 39/64	.362	3/8	7
		5.00	1.504	1 1/2	.264	17/64	
		4.00	**1.410**	**1 13/32**	**.170**	11/64	

Weights in heavy print are standard, others are special

MINIMUM AND MAXIMUM WEIGHTS AND DIM SIONS OF CAR-TRUCK AND SHIP-BUILDING CHANNELS

Section Index	Depth of Channel Inches	Weight per Foot Pounds		Flange Width Inches		Web Thickness Inches		Increase of Web and Flange for each lb. increase of weight
		Min.	Max.	Min.	Max.	Min.	Max.	
C 20	13	32.0	50.0	4.00	4.42	.38	.80	.023
C 109	6	15.0	....	3.50	....	.35	...	....
C 120	7	20.9	23.3	3.45	3.55	.45	.55	.042
C 130	8	23.8	26.5	3.50	3.60	.50	.60	.037
C 140	9	28.6	34.7	3.80	4.00	.45	.65	.033
C 150	10	27.2	30.6	3.50	3.60	.50	.60	.029
C 150b	10	21.8	....	3.38	....	.38	...	....
Rolls not turned up for the following Channels								
C 160	10	31.8	36.9	3.85	4.00	.50	.65	.029
C 170	12	44.3	48.4	4.00	4.10	.70	.80	.025

MINIMUM, MAXIMUM AND INTERMEDIAT WEIGHTS AND DIMENSIONS OF STANDARD Z-BARS

Section Index	Size, Inches			Thickness of Metal Inches	Weight per Foot Pounds
	Flange	Web	Flange		
Z 1	$3\frac{1}{2}$	6	$3\frac{1}{2}$	$\frac{3}{8}$	15.6
	$3\frac{9}{16}$	$6\frac{1}{16}$	$3\frac{9}{16}$	$\frac{7}{16}$	18.3
	$3\frac{5}{8}$	$6\frac{1}{8}$	$3\frac{5}{8}$	$\frac{1}{2}$	21.0
Z 2	$3\frac{1}{2}$	6	$3\frac{1}{2}$	$\frac{9}{16}$	22.7
	$3\frac{9}{16}$	$6\frac{1}{16}$	$3\frac{9}{16}$	$\frac{5}{8}$	25.4
	$3\frac{5}{8}$	$6\frac{1}{8}$	$3\frac{5}{8}$	$\frac{11}{16}$	28.0
Z 3	$3\frac{1}{2}$	6	$3\frac{1}{2}$	$\frac{3}{4}$	29.3
	$3\frac{9}{16}$	$6\frac{1}{16}$	$3\frac{9}{16}$	$\frac{13}{16}$	31.9
	$3\frac{5}{8}$	$6\frac{1}{8}$	$3\frac{5}{8}$	$\frac{7}{8}$	34.6
Z 4	$3\frac{1}{4}$	5	$3\frac{1}{4}$	$\frac{5}{16}$	11.6
	$3\frac{5}{16}$	$5\frac{1}{16}$	$3\frac{5}{16}$	$\frac{3}{8}$	13.9
	$3\frac{3}{8}$	$5\frac{1}{8}$	$3\frac{3}{8}$	$\frac{7}{16}$	16.4

MINIMUM, MAXIMUM AND INTERMEDIATE WEIGHTS AND DIMENSIONS OF STANDARD Z-BARS—Continued

tion dex	Size, Inches			Thickness of Metal Inches	Weight per Foot Pounds	Page No. of Section
	Flange	Web	Flange			
5	3¼ 3 5/16 3⅜	5 5 1/16 5⅛	3¼ 3 5/16 3⅜	½ 9/16 ⅝	17.9 20.2 22.6	10
6	3¼ 3 5/16 3⅜	5 5 1/16 5⅛	3¼ 3 5/16 3⅜	11/16 ¾ 13/16	23.7 26.0 28.3	10
7	3 1/16 3⅛ 3 3/16	4 4 1/16 4⅛	3 1/16 3⅛ 3 3/16	¼ 5/16 ⅜	8.2 10.3 12.4	11
8	3 1/16 3⅛ 3 3/16	4 4 1/16 4⅛	3 1/16 3⅛ 3 3/16	7/16 ½ 9/16	13.8 15.8 17.9	11
9	3 1/16 3⅛ 3 3/16	4 4 1/16 4⅛	3 1/16 3⅛ 3 3/16	⅝ 11/16 ¾	18.9 20.9 23.0	11
10	2 11/16 2¾	3 3 1/16	2 11/16 2¾	¼ 5/16	6.7 8.4	11
11	2 11/16 2¾	3 3 1/16	2 11/16 2¾	⅜ 7/16	9.7 11.4	11
12	2 11/16 2¾	3 3 1/16	2 11/16 2¾	½ 9/16	12.5 14.2	11

WEIGHTS AND DIMENSIONS OF SPECIAL Z-BARS

tion dex	Size, Inches			Thickness of Metal Inches	Weight Per Foot Pounds	Page No. of Section
	Flange	Web	Flange			
'3	3	6	3	⅜	14.5	12
9	1¼	1¾	2⅛	7/32	3.5	12

MINIMUM, MAXIMUM AND INTERMEDIATE WEIGHTS AND DIMENSIONS OF ANGLES

EQUAL LEGS

Section Index	Size Inches	Thickness of Metal	Weight per Foot Pounds	Area Square Inches
A113	8 x8	1⅛	56.9	16.73
A112	8 x8	1 1/16	54.0	15.87
A111	8 x8	1	51.0	15.00
A110	8 x8	15/16	48.1	14.12
A109	8 x8	⅞	45.0	13.23
A108	8 x8	13/16	42.0	12.34
A107	8 x8	¾	38.9	11.44
A106	8 x8	11/16	35.8	10.53
A105	8 x8	⅝	32.7	9.61
A104	8 x8	9/16	29.6	8.68
A103	8 x8	½	26.4	7.75
A 86	6 x6	1	37.4	11.00
A 87	6 x6	15/16	35.3	10.37
A 1	6 x6	⅞	33.1	9.74
A 2	6 x6	13/16	31.0	9.09
A 3	6 x6	¾	28.7	8.44
A 4	6 x6	11/16	26.5	7.78
A 5	6 x6	⅝	24.2	7.11
A 6	6 x6	9/16	21.9	6.43
A 7	6 x6	½	19.6	5.75
A 8	6 x6	7/16	17.2	5.06
A 88	6 x6	⅜	14.9	4.36
*A 94	5 x5	1	30.6	9.00
*A 95	5 x5	15/16	28.9	8.50
*A 9	5 x5	⅞	27.2	7.99
*A 10	5 x5	13/16	25.4	7.46
*A 11	5 x5	¾	23.6	6.94
*A 12	5 x5	11/16	21.8	6.42
*A 13	5 x5	⅝	20.0	5.86
*A 14	5 x5	9/16	18.1	5.
*A 15	5 x5	½	16.2	4.
*A 16	5 x5	7/16	14.3	4.
*A 17	5 x5	⅜	12.3	3.
A 18	4 x4	13/16	19.9	5.
A 19	4 x4	¾	18.5	5.
A 20	4 x4	11/16	17.1	5.
A 21	4 x4	⅝	15.7	4.
A 22	4 x4	9/16	14.3	4.
A 23	4 x4	½	12.8	3.
A 24	4 x4	7/16	11.3	3.
A 25	4 x4	⅜	9.8	2.
A 90	4 x4	5/16	8.2	2.
A 26	3½x3½	13/16	17.1	5.
A 27	3½x3½	¾	16.0	4.
A 28	3½x3½	11/16	14.8	4.
A 29	3½x3½	⅝	13.6	3.
A 30	3½x3½	9/16	12.4	3.
A 31	3½x3½	½	11.1	3.
A 32	3½x3½	7/16	9.8	2.
A 33	3½x3½	⅜	8.5	2.
A 99	3½x3½	5/16	7.2	2.
A 34	3 x3	⅝	11.5	3.
A 35	3 x3	9/16	10.4	3.
A 36	3 x3	½	9.4	2.
A 37	3 x3	7/16	8.3	2.
A 38	3 x3	⅜	7.2	2.

*Angles marked * are special.*

MINIMUM, MAXIMUM AND INTERMEDIATE WEIGHTS AND DIMENSIONS OF ANGLES—Continued

EQUAL LEGS

Section Index	Size Inches	Thickness of Metal	Weight per Foot Pounds	Area Square Inches	Section Index	Size Inches	Thickness of Metal	Weight per Foot Pounds	Area Square Inches
A 39	3 x3	5/16	6.1	1.78	A 61	1¾x1¾	7/16	4.6	1.30
A 40	3 x3	¼	4.9	1.44	A 62	1¾x1¾	⅜	4.0	1.17
					A 63	1¾x1¾	5/16	3.4	1.00
					A 64	1¾x1¾	¼	2.8	0.81
					A 65	1¾x1¾	3/16	2.2	0.62
A 41	2¾x2¾	½	8.5	2.50					
A 42	2¾x2¾	7/16	7.6	2.22					
A 43	2¾x2¾	⅜	6.6	1.92					
A 44	2¾x2¾	5/16	5.6	1.62	A 66	1½x1½	⅜	3.4	0.99
A 45	2¾x2¾	¼	4.5	1.31	A 67	1½x1½	5/16	2.9	0.84
					A 68	1½x1½	¼	2.4	0.69
					A 69	1½x1½	3/16	1.8	0.53
					A102	1½x1½	⅛	1.3	0.36
A 46	2½x2½	½	7.7	2.25					
A 47	2½x2½	7/16	6.8	2.00					
A 48	2½x2½	⅜	5.9	1.73					
A 49	2½x2½	5/16	5.0	1.47	A 70	1¼x1¼	5/16	2.4	0.69
A 50	2½x2½	¼	4.1	1.19	A 71	1¼x1¼	¼	2.0	0.56
A100	2½x2½	3/16	3.1	0.90	A 72	1¼x1¼	3/16	1.5	0.43
					A 73	1¼x1¼	⅛	1.1	0.30
A 51	2¼x2¼	½	6.8	2.00					
A 52	2¼x2¼	7/16	6.1	1.78	A 78	1 x1	¼	1.5	0.44
A 53	2¼x2¼	⅜	5.3	1.55	A 79	1 x1	3/16	1.2	0.34
A 54	2¼x2¼	5/16	4.5	1.31	A 80	1 x1	⅛	0.8	0.24
A 55	2¼x2¼	¼	3.7	1.06					
A101	2¼x2¼	3/16	2.8	0.81					
					*A 81	⅞x ⅞	3/16	1.0	0.29
					*A 82	⅞x ⅞	⅛	0.7	0.21
A 56	2 x2	7/16	5.3	1.56					
A 57	2 x2	⅜	4.7	1.36					
A 58	2 x2	5/16	4.0	1.15					
A 59	2 x2	¼	3.2	0.94	A 83	¾x ¾	3/16	0.9	0.25
A 60	2 x2	3/16	2.5	0.72	A 84	¾x ¾	⅛	0.6	0.17

Angles marked * are special.

MINIMUM, MAXIMUM AND INTERMEDIATE WEIGHTS AND DIMENSIONS OF ANGLES

UNEQUAL LEGS

Section Index	Size Inches		Thickness of Metal	Weight per Foot Pounds	Area Square Inches
*A140	8	x3½	11/20	20.5	6.02
*A150	7	x3½	1	32.3	9.50
*A151	7	x3½	15/16	30.5	8.97
*A152	7	x3½	7/8	28.7	8.42
*A153	7	x3½	13/16	26.8	7.87
*A154	7	x3½	3/4	24.9	7.31
*A155	7	x3½	11/16	23.0	6.75
*A156	7	x3½	5/8	21.0	6.17
*A157	7	x3½	9/16	19.1	5.59
*A158	7	x3½	1/2	17.0	5.00
*A159	7	x3½	7/16	15.0	4.40
A 89	6	x4	1	30.6	9.00
A 91	6	x4	15/16	28.9	8.50
A160	6	x4	7/8	27.2	7.99
A161	6	x4	13/16	25.4	7.47
A162	6	x4	3/4	23.6	6.94
A163	6	x4	11/16	21.8	6.41
A164	6	x4	5/8	20.0	5.86
A165	6	x4	9/16	18.1	5.31
A166	6	x4	1/2	16.2	4.75
A167	6	x4	7/16	14.3	4.18
A168	6	x4	3/8	12.3	3.61
A 92	6	x3½	1	28.9	8.50
A 93	6	x3½	15/16	27.3	8.03
A169	6	x3½	7/8	25.7	7.55

Section Index	Size Inches		Thickness of Metal	Weight per Foot Pounds	Ar Squ Inc
A170	6	x3½	13/16	24.0	7.
A171	6	x3½	3/4	22.4	6.
A172	6	x3½	11/16	20.6	6.
A173	6	x3½	5/8	18.9	5.
A174	6	x3½	9/16	17.1	5.
A175	6	x3½	1/2	15.3	4.
A176	6	x3½	7/16	13.5	3.
A177	6	x3½	3/8	11.7	3.
*A178	5	x4	7/8	24.2	7
*A179	5	x4	13/16	22.7	6
*A180	5	x4	3/4	21.1	6
*A181	5	x4	11/16	19.5	5
*A182	5	x4	5/8	17.8	5
*A183	5	x4	9/16	16.2	4
*A184	5	x4	1/2	14.5	4
*A185	5	x4	7/16	12.8	3
*A186	5	x4	3/8	11.0	3
A187	5	x3½	7/8	22.7	6
A188	5	x3½	13/16	21.3	6
A189	5	x3½	3/4	19.8	5
A190	5	x3½	11/16	18.3	5
A191	5	x3½	5/8	16.8	4
A192	5	x3½	9/16	15.2	4
A193	5	x3½	1/2	13.6	4.
A194	5	x3½	7/16	12.0	3.

Angles marked * are special

MINIMUM, MAXIMUM AND INTERMEDIATE WEIGHTS AND DIMENSIONS OF ANGLES—Continued

UNEQUAL LEGS

Section Index	Size Inches	Thickness of Metal	Weight per Foot Pounds	Area Square Inches	Section Index	Size Inches	Thickness of Metal	Weight per Foot Pounds	Area Square Inches
195	5 x3½	3/8	10.4	3.05	*A216	4 x3½	9/16	13.3	3.90
96	5 x3½	5/16	8.7	2.56	*A217	4 x3½	1/2	11.9	3.50
					*A218	4 x3½	7/16	10.6	3.09
					*A219	4 x3½	3/8	9.1	2.67
196	5 x3	13/16	19.9	5.84	*A 98	4 x3½	5/16	7.7	2.25
197	5 x3	3/4	18.5	5.44					
198	5 x3	11/16	17.1	5.03					
199	5 x3	5/8	15.7	4.61	A220	4 x3	13/16	17.1	5.03
200	5 x3	9/16	14.3	4.18	A221	4 x3	3/4	16.0	4.69
201	5 x3	1/2	12.8	3.75	A222	4 x3	11/16	14.8	4.34
202	5 x3	7/16	11.3	3.31	A223	4 x3	5/8	13.6	3.98
203	5 x3	3/8	9.8	2.86	A224	4 x3	9/16	12.4	3.62
280	5 x3	5/16	8.2	2.40	A225	4 x3	1/2	11.1	3.25
					A226	4 x3	7/16	9.8	2.87
					A227	4 x3	3/8	8.5	2.48
204	4½x3	13/16	18.5	5.43	A228	4 x3	5/16	7.2	2.09
205	4½x3	3/4	17.3	5.06					
206	4½x3	11/16	16.0	4.68	A229	3½x3	13/16	15.8	4.62
207	4½x3	5/8	14.7	4.30	A230	3½x3	3/4	14.7	4.31
208	4½x3	9/16	13.3	3.90	A231	3½x3	11/16	13.6	4.00
209	4½x3	1/2	11.9	3.50	A232	3½x3	5/8	12.5	3.67
210	4½x3	7/16	10.6	3.09	A233	3½x3	9/16	11.4	3.34
211	4½x3	3/8	9.1	2.67	A234	3½x3	1/2	10.2	3.00
97	4½x3	5/16	7.7	2.25	A235	3½x3	7/16	9.1	2.65
					A236	3½x3	3/8	7.9	2.30
212	4 x3½	13/16	18.5	5.43	A237	3½x3	5/16	6.6	1.93
213	4 x3½	3/4	17.3	5.06					
214	4 x3½	11/16	16.0	4.68	A238	3½x2½	11/16	12.5	3.65
215	4 x3½	5/8	14.7	4.30	A239	3½x2½	5/8	11.5	3.36

*Angles marked * are special*

MINIMUM, MAXIMUM AND INTERMEDIATE WEIGHTS AND DIMENSIONS OF ANGLES—Continued

UNEQUAL LEGS

Section Index	Size Inches	Thickness of Metal	Weight per Foot Pounds	Area Square Inches	Section Index	Size Inches	Thickness of Metal	Weight per Foot Pounds	Ar Squ Inc
A240	3½x2½	9/16	10.4	3.06	*A261	3 x2	5/16	5.0	1.
A241	3½x2½	½	9.4	2.75	*A262	3 x2	¼	4.1	1.
A242	3½x2½	7/16	8.3	2.43					
A243	3½x2½	⅜	7.2	2.11					
A244	3½x2½	5/16	6.1	1.78					
A245	3½x2½	¼	4.9	1.44	A264	2½x2	½	6.8	2.
					A265	2½x2	7/16	6.1	1.
					A266	2½x2	⅜	5.3	1.
					A267	2½x2	5/16	4.5	1.
*A246	3¼x2	9/16	9.0	2.64	A268	2½x2	¼	3.7	1.
*A247	3¼x2	½	8.1	2.38	A269	2½x2	3/16	2.8	0.
*A248	3¼x2	7/16	7.2	2.11					
*A249	3¼x2	⅜	6.3	1.83					
*A250	3¼x2	5/16	5.3	1.54					
*A251	3¼x2	¼	4.3	1.25	*A270	2¼x1½	½	5.6	1.
					*A271	2¼x1½	7/16	5.0	1.
					*A272	2¼x1½	⅜	4.4	1.
					*A273	2¼x1½	5/16	3.7	1.
A252	3 x2½	9/16	9.5	2.78	*A274	2¼x1½	¼	3.0	0.
A253	3 x2½	½	8.5	2.50	*A275	2¼x1½	3/16	2.3	0.
A254	3 x2½	7/16	7.6	2.22					
A255	3 x2½	⅜	6.6	1.92					
A256	3 x2½	5/16	5.6	1.62					
A257	3 x2½	¼	4.5	1.31	*A276	2 x1⅜	¼	2.7	0.
					*A277	2 x1⅜	3/16	2.1	0.
*A258	3 x2	½	7.7	2.25					
*A259	3 x2	7/16	6.8	2.00	*A278	1⅜x1	¼	1.9	0.
*A260	3 x2	⅜	5.9	1.73	*A279	1⅜x1	⅛	1.0	0.

Angles marked * are special

INIMUM, MAXIMUM AND INTERMEDIATE WEIGHTS AND DIMENSIONS OF SPECIAL ANGLES

SQUARE ROOT

Size Inches	Thickness of Metal Inches	Weight per Foot Pounds	Section Index	Size Inches	Thickness of Metal Inches	Weight per Foot Pounds
4 x 4	¾	18.5	A385	2¼ x 2¼	⅜	5.3
4 x 4	11/16	17.1	A386	2¼ x 2¼	5/16	4.5
4 x 4	⅝	15.7	A387	2¼ x 2¼	¼	3.7
4 x 4	9/16	14.3				
4 x 4	½	12.8	A388	2 x 2	7/16	5.3
4 x 4	7/16	11.3	A389	2 x 2	⅜	4.7
4 x 4	⅜	9.8	A390	2 x 2	5/16	4.0
			A391	2 x 2	¼	3.2
3½ x 3½	¾	16.0				
3½ x 3½	11/16	14.8	A392	1¾ x 1¾	7/16	4.6
3½ x 3½	⅝	13.6	A393	1¾ x 1¾	⅜	4.0
3½ x 3½	9/16	12.4	A394	1¾ x 1¾	5/16	3.4
3½ x 3½	½	11.1	A395	1¾ x 1¾	¼	2.8
3½ x 3½	7/16	9.8				
3½ x 3½	⅜	8.5	A396	1½ x 1½	⅜	3.4
			A397	1½ x 1½	5/16	2.9
3 x 3	⅝	11.5	A398	1½ x 1½	¼	2.4
3 x 3	9/16	10.4	A399	1½ x 1½	3/16	1.8
3 x 3	½	9.4				
3 x 3	7/16	8.3	A400	1¼ x 1¼	5/16	2.4
3 x 3	⅜	7.2	A401	1¼ x 1¼	¼	2.0
3 x 3	5/16	6.1	A402	1¼ x 1¼	3/16	1.5
3 x 3	¼	4.9	A403	1¼ x 1¼	⅛	1.1
2¾ x 2¾	½	8.5	A406	1⅛ x 1⅛	¼	1.7
2¾ x 2¾	7/16	7.6	A407	1⅛ x 1⅛	3/16	1.3
2¾ x 2¾	⅜	6.6	A408	1⅛ x 1⅛	⅛	0.9
2¾ x 2¾	5/16	5.6	A430	1 1/16 x 13/16	3/16	1.1
			A409	1 x 1	¼	1.5
2½ x 2½	½	7.7	A410	1 x 1	3/16	1.2
2½ x 2½	7/16	6.8	A411	1 x 1	⅛	0.8
2½ x 2½	⅜	5.9				
2½ x 2½	5/16	5.0	A412	⅞ x ⅞	3/16	1.0
2½ x 2½	¼	4.1	A413	⅞ x ⅞	⅛	0.7
2¼ x 2¼	½	6.8	A414	¾ x ¾	3/16	0.9
2¼ x 2¼	7/16	6.1	A415	¾ x ¾	⅛	0.6

WEIGHTS AND DIMENSIONS OF CARNEGIE T

EQUAL LEGS

Section Index	Size, Inches		Thickness of Metal, Inches		Weight per Foot Pounds
	Flange	Stem	Flange	Stem	
T 1	4	4	½ to $\frac{9}{16}$	½ to $\frac{9}{16}$	13.9
T 2	4	4	⅜ to $\frac{7}{16}$	⅜ to $\frac{7}{16}$	10.9
T 3	3½	3½	½ to $\frac{9}{16}$	½ to $\frac{9}{16}$	11.9
T 4	3½	3½	⅜ to $\frac{7}{16}$	⅜ to $\frac{7}{16}$	9.3
T 6	3	3	½ to $\frac{9}{16}$	½ to $\frac{9}{16}$	10.1
T 7	3	3	$\frac{7}{16}$ to ½	$\frac{7}{16}$ to ½	9.0
T 8	3	3	⅜ to $\frac{7}{16}$	⅜ to $\frac{7}{16}$	7.9
T 9	3	3	$\frac{5}{16}$ to ⅜	$\frac{5}{16}$ to ⅜	6.8
T 10	2½	2½	⅜ to $\frac{7}{16}$	⅜ to $\frac{7}{16}$	6.5
T 11	2½	2½	$\frac{5}{16}$ to ⅜	$\frac{5}{16}$ to ⅜	5.6
T 12	2¼	2¼	$\frac{5}{16}$ to ⅜	$\frac{5}{16}$ to ⅜	5.0
T 13	2¼	2¼	¼ to $\frac{5}{16}$	¼ to $\frac{5}{16}$	4.2
T 14	2	2	$\frac{5}{16}$ to ⅜	$\frac{5}{16}$ to ⅜	4.4
T 15	2	2	¼ to $\frac{5}{16}$	¼ to $\frac{5}{16}$	3.7
T 16	1¾	1¾	¼ to $\frac{5}{16}$	¼ to $\frac{5}{16}$	3.2
T 17	1½	1½	¼ to $\frac{9}{32}$	¼ to $\frac{9}{32}$	2.6
T 18	1½	1½	$\frac{3}{16}$ to $\frac{7}{32}$	$\frac{3}{16}$ to $\frac{7}{32}$	2.0
T 19	1¼	1¼	¼ to $\frac{9}{32}$	¼ to $\frac{9}{32}$	2.1
T 20	1¼	1¼	$\frac{3}{16}$ to $\frac{7}{32}$	$\frac{3}{16}$ to $\frac{7}{32}$	1.7
T 21	1	1	$\frac{3}{16}$ to $\frac{7}{32}$	$\frac{3}{16}$ to $\frac{7}{32}$	1.3
T 22	1	1	⅛ to $\frac{5}{32}$	⅛ to $\frac{5}{32}$	1.0

EIGHTS AND DIMENSIONS OF CARNEGIE TEES

UNEQUAL LEGS

Section Index	Size, Inches		Thickness of Metal, Inches		Weight per Foot Pounds	Page No. of Section
	Flange	Stem	Flange	Stem		
T 50	5	3	$\frac{1}{2}$ to $\frac{9}{16}$	$\frac{13}{32}$ to $\frac{5}{8}$	13.6	20
T 51	5	$2\frac{1}{2}$	$\frac{3}{8}$ to $\frac{7}{16}$	$\frac{7}{16}$ to $\frac{21}{32}$	11.0	20
T 52	$4\frac{1}{2}$	$3\frac{1}{2}$	$\frac{7}{16}$ to $\frac{9}{16}$	$\frac{11}{16}$ to $\frac{7}{8}$	15.9	20
T 53	$4\frac{1}{2}$	3	$\frac{5}{16}$ to $\frac{3}{8}$	$\frac{5}{16}$ to $\frac{3}{8}$	8.6	20
T 54	$4\frac{1}{2}$	3	$\frac{3}{8}$ to $\frac{7}{16}$	$\frac{3}{8}$ to $\frac{7}{16}$	10.0	20
T 55	$4\frac{1}{2}$	$2\frac{1}{2}$	$\frac{5}{16}$ to $\frac{3}{8}$	$\frac{5}{16}$ to $\frac{3}{8}$	8.0	20
T 56	$4\frac{1}{2}$	$2\frac{1}{2}$	$\frac{3}{8}$ to $\frac{7}{16}$	$\frac{3}{8}$ to $\frac{7}{16}$	9.3	20
T 57	4	5	$\frac{1}{2}$ to $\frac{9}{16}$	$\frac{1}{2}$ to $\frac{9}{16}$	15.7	20
T 58	4	5	$\frac{3}{8}$ to $\frac{7}{16}$	$\frac{3}{8}$ to $\frac{7}{16}$	12.3	21
T 59	4	$4\frac{1}{2}$	$\frac{1}{2}$ to $\frac{9}{16}$	$\frac{1}{2}$ to $\frac{9}{16}$	14.8	21
T 60	4	$4\frac{1}{2}$	$\frac{3}{8}$ to $\frac{7}{16}$	$\frac{3}{8}$ to $\frac{7}{16}$	11.6	21
T 61	4	3	$\frac{3}{8}$ to $\frac{7}{16}$	$\frac{3}{8}$ to $\frac{7}{16}$	9.3	21
T 62	4	$2\frac{1}{2}$	$\frac{3}{8}$ to $\frac{7}{16}$	$\frac{3}{8}$ to $\frac{7}{16}$	8.7	21
T 63	4	$2\frac{1}{2}$	$\frac{5}{16}$ to $\frac{3}{8}$	$\frac{5}{16}$ to $\frac{3}{8}$	7.4	21
T 64	4	2	$\frac{3}{8}$ to $\frac{7}{16}$	$\frac{3}{8}$ to $\frac{7}{16}$	7.9	21
T 65	4	2	$\frac{5}{16}$ to $\frac{3}{8}$	$\frac{5}{16}$ to $\frac{3}{8}$	6.7	21
T 66	$3\frac{1}{2}$	4	$\frac{1}{2}$ to $\frac{9}{16}$	$\frac{1}{2}$ to $\frac{9}{16}$	12.8	22
T 67	$3\frac{1}{2}$	4	$\frac{3}{8}$ to $\frac{7}{16}$	$\frac{3}{8}$ to $\frac{7}{16}$	10.0	22
T 69	$3\frac{1}{2}$	3	$\frac{1}{2}$ to $\frac{9}{16}$	$\frac{1}{2}$ to $\frac{9}{16}$	11.0	22
T 70	$3\frac{1}{2}$	3	$\frac{3}{8}$ to $\frac{7}{16}$	$\frac{3}{8}$ to $\frac{7}{16}$	8.7	22
T 71	$3\frac{1}{2}$	3	$\frac{5}{16}$ to $\frac{3}{8}$	$\frac{3}{8}$	7.7	22
T 72	3	4	$\frac{1}{2}$ to $\frac{9}{16}$	$\frac{1}{2}$ to $\frac{9}{16}$	11.9	22
T 73	3	4	$\frac{7}{16}$ to $\frac{1}{2}$	$\frac{7}{16}$ to $\frac{1}{2}$	10.6	22

WEIGHTS AND DIMENSIONS OF CARNEG

TEES—Continued

UNEQUAL LEGS

Section Index	Size, Inches		Thickness of Metal, Inches		Weight per Foot Pounds	P S
	Flange	Stem	Flange	Stem		
T 74	3	4	3/8 to 7/16	3/8 to 7/16	9.3	
T 75	3	3½	½ to 9/16	½ to 9/16	11.0	
T 76	3	3½	7/16 to ½	7/16 to ½	9.8	
T 77	3	3½	3/8 to 7/16	3/8 to 7/16	8.6	
T 78	3	2½	3/8 to 7/16	3/8 to 7/16	7.2	
T 79	3	2½	5/16 to 3/8	5/16 to 3/8	6.2	
T 80	2¾	2	5/16 to 11/32	¾	7.4	
T 82	2½	3	3/8 to 7/16	3/8 to 7/16	7.2	
T 83	2½	3	5/16 to 3/8	5/16 to 3/8	6.2	
T 84	2½	2¾	3/8 to 7/16	3/8 to 7/16	6.8	
T 85	2½	2¾	5/16 to 3/8	5/16 to 3/8	5.9	
T 86	2½	1¼	3/16 to 9/32	3/16 to 5/16	3.0	
T 87	2	1½	¼ to 5/16	¼ to 5/16	3.2	

HAND-RAIL TEES

Section Index	Size Inches	Weight per Foot Pounds	Page No. of Section	Section Index	Size Inches	Weight per Foot Pounds	P S
T 154	4½ x 2 3/16	7.00	19	T 156	4 x 3	11.30	

WEIGHTS AND DIMENSIONS OF CARNEGIE MISCELLANEOUS SHAPES

TROUGH PLATES

Section Index	Size Inches	Thickness of Metal Inches	Weight per Foot, Pounds	Page No. of Section
M 10	$9\frac{1}{2} \times 3\frac{3}{4}$	$\frac{1}{2}$	16.3	24
M 11	$9\frac{1}{2} \times 3\frac{3}{4}$	$\frac{9}{16}$	18.0	....
M 12	$9\frac{1}{2} \times 3\frac{3}{4}$	$\frac{5}{8}$	19.7	....
M 13	$9\frac{1}{2} \times 3\frac{3}{4}$	$\frac{11}{16}$	21.4	....
M 14	$9\frac{1}{2} \times 3\frac{3}{4}$	$\frac{3}{4}$	23.2	....

CORRUGATED PLATES

Section Index	Size Inches	Thickness of Metal Inches	Weight per Foot, Pounds	Page No. of Section
M 30	$8\frac{3}{4} \times 1\frac{1}{2}$	$\frac{1}{4}$	8.1	24
M 31	$8\frac{3}{4} \times 1\frac{9}{16}$	$\frac{5}{16}$	10.1	....
M 32	$8\frac{3}{4} \times 1\frac{5}{8}$	$\frac{3}{8}$	12.0	....
M 33	$12\frac{3}{16} \times 2\frac{3}{4}$	$\frac{3}{8}$	17.75	24
M 34	$12\frac{3}{16} \times 2\frac{13}{16}$	$\frac{7}{16}$	20.71	....
M 35	$12\frac{3}{16} \times 2\frac{7}{8}$	$\frac{1}{2}$	23.67	....

CHECKERED PLATES

Section Index	Width Inches	Thickness of Metal Inches	Weight per Sq. Foot, Pounds	Page No. of Section
M 51	34	$\frac{5}{16}$	13.8	24
M 52	34	$\frac{3}{8}$	16.3	....
M 53	34	$\frac{7}{16}$	18.9	....
M 54	34	$\frac{1}{2}$	21.4	....

CONSTRUCTIONAL DETAIL

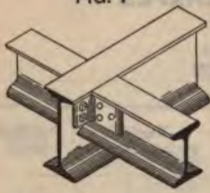


FIG. 1

FIG. 2

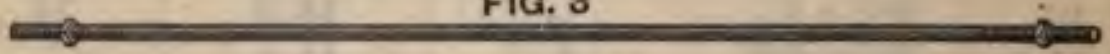


FIG. 3

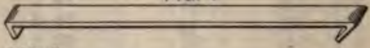


FIG. 4

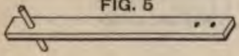


FIG. 5

FIG. 8

FIG. 9

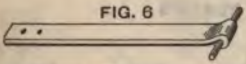


FIG. 6

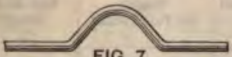


FIG. 7

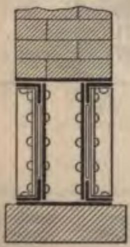


FIG. 10

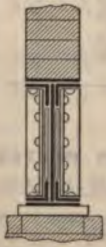


FIG. 11

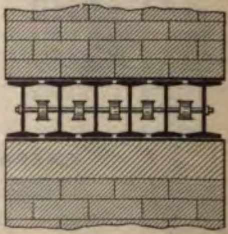


FIG. 12

FIG. 13

FIG. 14

FIG. 15

FIG. 16

FIREPROOF FLOORS

FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

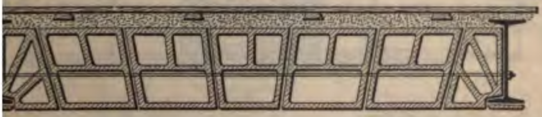


FIG. 6

FIG. 7

FIREPROOF FLOORS, SUSPENDED C
AND PARTITIONS

FIG. 1

FIG. 2

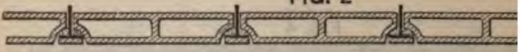


FIG. 3

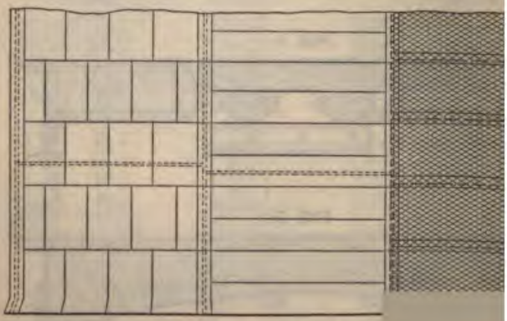


FIG. 4

ETAILS SHOWING FIREPROOFING AND BASES FOR Z-BAR COLUMNS

FIG. 2

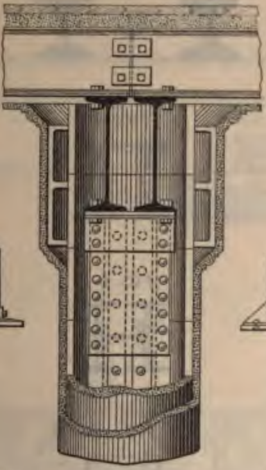


FIG. 1

FIG. 3

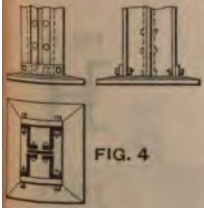


FIG. 4

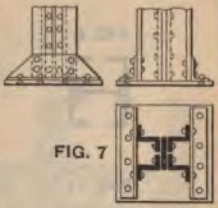


FIG. 7

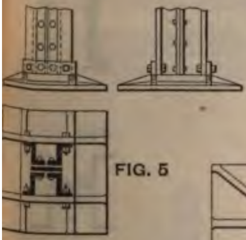


FIG. 5

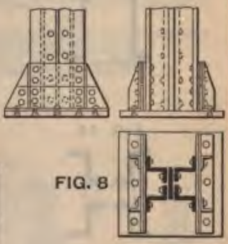


FIG. 8

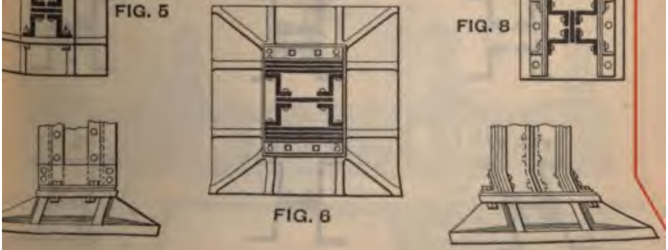


FIG. 6

BUILT COLUMN SECTIONS

FIG. 1

FIG. 2

FIG. 3

FIG. 5

FIG. 6

FIG. 8

FIG. 9

FIG. 11

FIG. 12

FIG. 14

FIG. 15

FIG. 17

FIG. 18

TYPES OF CANTILEVERS

FIG. I

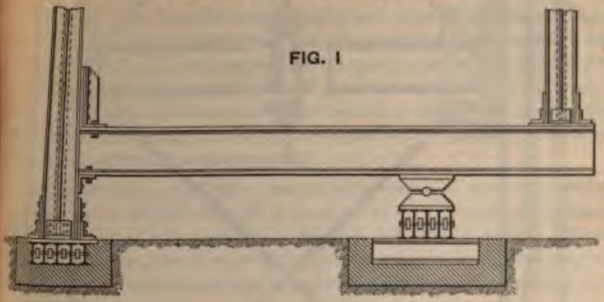


FIG. 2

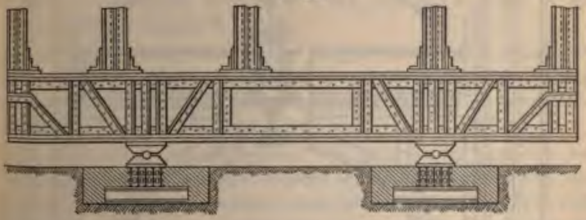
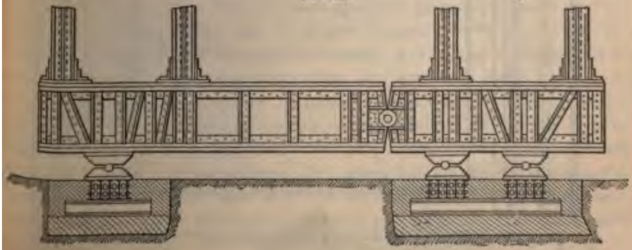
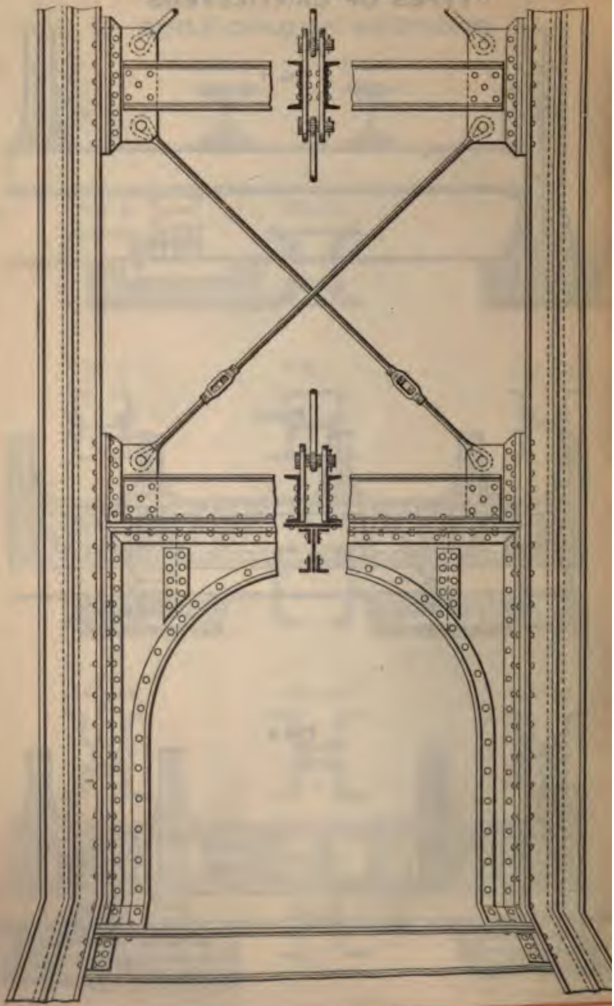


FIG. 3



TYPES OF WIND BRACING



NOTES ON FOUNDATIONS

In designing the foundations of walls and piers of buildings, when y rest upon a yielding stratum, proper provision must be made for uniform distribution of the weight. In case the walls are of different knesses and heights, the widths of the foundations must be propor- d according to the different loads resulting therefrom, so that the ing per unit of ground area will be equal and a uniform settlement e completed structure is insured.

he introduction of timber beams as a means of obtaining wider ng surfaces at the base is a practice to be strongly condemned, s the wood is in a position to remain continually moist. Where s not the case, the timber will soon rot away, thereby causing an ial settlement of the walls which is very injurious, if not destructive, masonry.

ails imbedded in concrete are not open to this objection. They however, comparatively little resistance to deflection, and for this , if allowed to project beyond the masonry to any considerable , the concrete filling is liable to crack, and the strength of the ation becomes impaired.

beams, more recently used for this purpose, are found to be superior ry respect. A greater depth can be adopted, the deflection thus ed to a minimum and a sufficient saving effected to more than nsate for their additional cost per pound.

e foundation should be prepared (see illustrations pages 164, 166) t laying a bed of concrete to a depth of from 4 to 12 inches and then g upon this a row of I-beams at right angles to the face of the wall. case of heavy piers the beams may be crossed in two directions. distances apart, from center to center, may vary from 9 to 24 in. ding to circumstances, *i. e.*, length of their projection beyond the ry, thickness of concrete, estimated pressure per square foot, etc. should be placed at least far enough apart to permit the introduc- f the concrete filling and its proper tamping between the beams. s the concrete is of unusual thickness, it will not be advisable to d 20 in. spacing, since otherwise the concrete may not be of ent strength to properly transmit the upward pressure to the s. The most useful application of this method of founding is in ies where a thin and comparatively compact stratum overlies er of a more yielding nature. By using I-beams in such cases, the te spread at the base may be obtained without either pene- the firm upper stratum or carrying the footing-courses to such as to encroach unduly upon the basement-room.

CANTILEVERS

In buildings where it is not desirable to undermine th adjoining property, or where the building laws do not perm of the foundations being carried under the same, cantilev girders are used to carry the columns next to the building lin

Three different designs of cantilevers, as actually applie are shown on page 52. Fig. 1 shows deep steel beams, use when the load on the columns resting on the cantilever pr duces such bending moments as can be taken up by the beam it also shows a connection for the other end of the cantilever t an interior column. Evidently, the product obtained by mult plying the load on the interior column by the distance from i center to the fulcrum foundation must be greater than that the load on the wall column times its distance to the fulcru foundation. Should it be less, the interior column must b anchored down to an especially designed foundation.

The load on the fulcrum foundation is equal to the sum the loads on the wall column and the reaction of the cantilev at the interior column. Fig. 2 shows a method of cantilev construction where it is not desirable to have a separat foundation under each column and a heavy box girder of sui able design is used to transmit the various column loads to tw independent foundations.

The reaction on foundations due to the different colum loads can be quickly determined by means of well-know formulæ.

In Fig. 3 is shown a special design which avoids the use a continuous girder.

The stresses in a continuous girder with supports fixed ca *be readily* determined; but as it is impossible to fix the s *ports, i. e.*, to prevent unequal settlement, this form of g

e avoided if possible. There are, however, conditions ake their application desirable. On the other hand, a antilever admits of easy calculation and adapts itself light settlements that may occur without materially the reactions on the foundations or changing the in the girder.

important feature in connection with cantilever con- is to adopt a pin support in place of resting the canti- am directly on the top course of the foundation beams. he cantilever rests directly upon the upper course of ion beams without a pin support, the outer beam near- wall column will be strained more than any of the nd thus the center of pressure will not be exactly in dle of the foundation, as it should be.

extra cost involved in the two shoes and pin is very compared to the desirability of having the center of in the center of the foundation.

shoes for ordinary loads and conditions are made solid iron and the pin of steel. The height of each shoe not be less than 6 in. and the pin 2½ in. diameter. dividual case should be figured by itself.

pin need be figured for bearing only, as it extends the whole length of the casting. A clearance of ½ in. is given between the cast shoes, which are always nd the hole bored to suit the pin.

NOTES ON WIND BRACING

On page 53 are shown two types of wind bracing use buildings. The upper one shows the method of bracing usı applied where no openings such as doors and windows oc This construction has adjustable diagonals properly fasten the adjacent columns in the building. The horizontal com nents of the stresses in the diagonals are taken up by m of two latticed channel bars located in the floor system of different floors. The vertical components are taken up the columns themselves and must be added to the other l to which the columns are subjected. In this calculation should be taken to provide for such design as to avoid ecce stresses on the columns. Should the design be such a cause these stresses, the columns must be figured accordin

If desirable, the diagonals may run through one and attach to the columns at the floors above and below intermediate floor; thus in some instances passageways be obtained.

The other type of wind bracing shows what is know portal bracing. This arch design recommends itself for u buildings where the diagonal system cannot be applie account of lack of room. It is usually placed between a cent columns in halls or passageways and extends from foundations up, from floor to floor, to such a height that stability of the building itself is sufficient to resist the assu wind pressure. In general, wind bracing should be pla if the building is square or nearly so, close to the corners; a parallelogram shape, in the direction parallel with the l width and at such points as to equally divide the stress all the panels. In case neither of the above methods ca applied, brackets should be used at each floor level or a tinuous deep beam or girder carried all around the build In either case the number of rivets fastening the columns girders should be carefully figured, as upon the value of resistance of these rivets, as well as the girders and brac depends the stability of the structure. In the last two m tioned methods the columns will all be subject to a ben stress which should be added to the other loads of the colu Besides this, they will be subject to vertical loads res from the resistance they offer to the overturning m of the wind against the structure.

GIRDERS IN BUILDINGS

In the design of a building, cases may occur where a single -beam girder will not answer. It may be found desirable to ncrease the length of the spans so as to reduce the number of upporting columns to a minimum, or perhaps heavy concenrated loads, such as columns, brick walls, etc., will render ingle I-beam girders inadequate. On page 47, Figs. 10 to 16 nclusive, are shown various forms of girders that may be used n such cases. Where the ends of the girders rest upon the wall, steel bearing plates (Figs. 11 and 12) should be used to distribute the pressure over a greater surface and thereby prevent the crushing of the material in the wall directly under the girder. Standard wall plates are given on pages 177, 179 and 181. In some cases a large, tough stone will answer without the plates (Fig. 10), but where the pressure is heavy, both plates and stone should be used (Fig. 12).

The allowed pressure per square foot for first-class brick work should not exceed eleven tons and for ordinary masonry eighteen tons.

For spanning openings in brick walls, girders composed of two or more I-beams connected by bolts and separators (Figs. 12 and 15, page 47) are most commonly used.

Where the bricks have been laid regularly, the probable line of rupture, if the girders should fail, will be found to be inside of the sides of an isosceles triangle whose base is the span and whose height is ⅓ of the span. In order to be entirely on the safe side, the weight of wall between vertical lines directly over the girder for a height equal to that of the triangle is frequently adopted as the load to be carried. It should be noted, however, that for green walls or walls having openings this rule does not apply.

Placing the weight of brick work at 112 lbs. per cubic foot, the weights per superficial foot for different walls are as follows:

For 9 in. wall	84 lbs.
" 13 in. "	121 "
" 18 in. "	168 "
" 22 in. "	205 "
" 26 in. "	243 "

GENERAL NOTES ON FLOORS

Examples of floor joists and their connections of common occurrence are shown on page 47, Figs. 1 and 2. Girders consisting of two I-beams or more, side by side, as in Figs. 12 and 15, should be connected by means of bolts and cast-iron separators fitting closely between the flanges of the beams. The office of these separators is, in a measure, to hold in position the compression flanges of the beams, preventing side deflection or buckling, and to unite the two beams so as to cause them to act in unison as regards vertical deflection. Separators should be provided near the supports and at points where heavy loads are imposed, otherwise at regular intervals of from 5 to 6 feet; these are shown in Figs. 8 and 9. Complete tables for the weights of separators for I-beams are given on page 175.

On page 47, Figs. 1 and 2 show different methods of connecting beams with each other. Fig. 1 represents the floor beam coped to the girder and joined to it by means of a pair of connecting angles, which are usually riveted to the floor beam and bolted to the girder. Notes on standard sizes of these connecting angles for all sizes of I-beams and channels are given with illustrations on page 178 to 186. Fig. 2 shows the floor beam resting on shelf angles riveted to the girder. Stiffening angles are usually placed under these shelf angles to take up the bending in the same and should contain a sufficient number of rivets to take up the end reaction of the floor beam. This method is usually adopted to facilitate the work of erection when the girders are composed of two or more beams and of sufficient depth to allow the floor beam to abut against the girder without being coped.

The old method of constructing fireproof floors in buildings is by means of brick arches. These usually consist of a single

ı. course of brick with a rise at the center of 3 or 4 in. and ıting on the lower flanges of the I-beams against brick skew-cks. This method of construction is illustrated on page 48, g. 7. In case the floor is designed for very heavy loads, veral courses of brick should be used. The floor beams ould be placed about 5 or 6 ft., center to center. A con-nient device for centering the arches consists of wooden ames, called centers, suspended by iron hooks from the lower anges of the beams and detachable on one side so that they ay be shifted at pleasure as the work progresses. The space bove the arches is filled with concrete in which are embedded ooden strips for securing the flooring. To finish the ceiling elow, plaster is generally applied on the bottom of the arches irectly to the brick work. The horizontal thrust of the arches s provided for by the use of tie rods from ⅝ in. to ⅞ in. iameter spaced along the center line of the beams, or a little elow, at regular intervals of from 5 to 7 ft. The thrust f these arches per lineal foot can be found by the formula $= \frac{1.5WL^2}{R}$, in which W is equal to the load per square foot, R he rise of the arch in inches and L the span in feet. The tie ods in the arch abutting against the wall are securely anchored the wall; an angle, channel or simply a wall plate can be sed to support the arch and to properly distribute the load pon the wall. The weight of a fireproof floor of this descrip-ion, that is, of 4 in. brick arches, concrete and flooring, exclu-ive of the weight of the beams, will average about 70 lbs. per quare foot.

Corrugated sheets may be used instead of the brick arches. hey are placed against the lower flanges of the I-beams and hus securely held in position while the space above is filled ith grouting. Tie rods are used the same as in the previous

case. The distance between beams should be limited to
6 ft. The corrugated sheets are usually left exposed belo
form the ceiling, and are thus open to the objection that
moisture in the atmosphere may condense upon the surfac
the sheets in sufficient quantities to drop into the room bel
Ceilings of this kind should therefore be restricted in th
use, or the sheets properly protected from contact with the

Two modern types of fireproof floor construction wh
have grown in favor so rapidly as to be used now almost to
exclusion of all others are illustrated on page 48, Figs. 4 and
The arches in this case are formed of hollow blocks consist
of burnt fire-clay or similar refractory material. These
furnished by the manufacturers in a great variety of patte
and of a strength to meet the desired requirements.

In regard to their composition, there may be said to e
two distinct varieties.

In the first, known as hollow pottery, the material cons
of burnt fire-clay and differs from the second variety, ca
"porous earthenware," in being thinner, harder and m
compact.

In the second variety, the clay before it is burnt is m
with sawdust and finely cut straw, which, being consu
during the process of burning, leaves the material in a fi
honeycombed state.

Figs. 4 and 5 on page 48 show two methods of const
tion of hollow pottery and porous earthenware arches.
method illustrated by Fig. 4 is the later and better.

From tests recently made, it appears that this latter
struction gives the best results in regard to strength. Th
evidently due to the fact that the full section of the mat
is placed in its most advantageous position to take the d
pressure coming thereon.

When used in floor construction both varieties of arches are :ked to the depth of several inches with concrete in which › embedded wooden strips to which the floor planking is :ured. The joints should be made radial and the blocks ould be thoroughly cemented together. They are made to oject about 1 inch below the bottom flange of the I-beams, hich are further protected by the insertion of a thin strip of le. The weight and cost of both hollow pottery and porous rthenware are about the same, and through their superior ghtness they possess an important advantage over the brick rch. The saving in weight amounts to from 40 to 50 per cent., hus warranting more economical proportions for the steel framing, while in other respects the cost of this construction is about the same. The weight of these arches per square foot of floor without plastering, concrete or flooring is about as follows:

12 in. arches, used for	warehouses	45 lbs.
10 " " " "	theatres	36 "
8 " " " "	office buildings	30 "
6 " " " "	light purposes	22 "

It is to be noted that such fireproof floors as fill the spaces between the floor beams, together with the tie rods forming a thoroughly braced floor, are better suited to meet the conditions of a high structure than if the spaces between the beams are not braced, as it is through this stiffness that wind stresses are more equally distributed to all the columns.

Horizontal bracing by means of diagonal rods or bars laid in the floor system should be avoided on account of difficult details of connection. This is not necessary if a proper fireproof floor, as outlined above, is adopted.

Fig. 6, page 48, shows a type of fireproof floor composed of *Carnegie trough sections*; this style of floor is used in buildings

where extremely heavy loads must be sustained, and al railway bridges.

The following are the usual assumptions made in practice for superimposed loads:

Floors of dwellings and offices	70 lbs. per	
" " churches, theaters and ballrooms	125 "	"
" " warehouses	200 to 250 "	"
" for heavy machinery . . .	250 to 400 "	"

The building laws of many of our large cities have re fixed superimposed loads for floors in buildings depending the purpose for which the building is to be used, and it these loads that the floors must be designed. In genera compare favorably with the above.

Where girders extend below bottom of floor beams are made fireproof by surrounding them with hollow ea ware blocks especially made to fit the bottom of the bea shown on page 48, Figs. 1, 2 and 3.

Examples of fireproof tile construction, as applied t ings and roofs, are given on page 49. In Fig. 2 the te suspended from the lower flanges of the I-beams at interv 12 in. or 15 in. and support a layer of very thin tile, wei about 5 lbs. per square foot, to which the plastering is ap For roofs somewhat heavier tees are used, resting on th flanges of the I-beams and spaced about 18 in. apart. tiling, weighing about 10 lbs. per square foot, may be co with concrete, then with a layer of felt and gravel, or i case of slate roofs, the slate may be nailed directly to the t

In Fig. 3 is shown a new type of suspended ceiling recommends itself for easy erection. Upon the rafter b are placed light purlin angles between which are hung ro supporting the ceiling tees.

Between the purlin angles are laid tile, then a course of concrete to level up, and two coats of asphalt. Upon the ceiling tees are placed like tiles; or metal lath can be wired directly to them, on which the plastering is applied.

A semi-fireproof construction which may be used to advantage in dwellings is shown on page 49, Fig. 1, and consists of angles resting on the top of the floor beams and supporting wooden strips. The finished floor can be directly nailed on these latter, which are spaced from 12 to 16 in. apart. The ceiling is composed of wire lathing, which is fastened to tees suspended from the floor beams and spaced about 16 in. apart. The plastering is applied directly to the wire lathing, and thus a level ceiling is obtained.

Wire lathing can also be used to good advantage in fireproofing columns and girders, and has shown itself to be of great utility in many instances where hollow pottery could not be used.

On page 49, Fig. 4, is given an elevation and section of three methods used in the construction of fireproof partitions. One consists of the ordinary fireproof square blocks, set with broken joints and held at intervals with light I-beams, which take the place of wood studding.

In the second method, the space between the I-beams is filled with a material called plaster boards. The third method consists of wire lathing attached to the flanges of the I-beams and stiffened at intervals of 2 feet with angles. In all these methods plastering is applied directly to the surfaces in the usual manner.

EXPLANATION OF TABLES ON SAFE LOADS SPACING FOR CARNEGIE SECTIONS

(Pages 69 to 88 inclusive)

The tables on pages 70 to 72 for I-beams give the which a beam will carry safely (distributed uniformly ov length) for the distances between supports indicated. ' loads include the weight of the beam, which must be ded in order to arrive at the *net load* which the beam will On pages 73 to 80 will also be found the safe loads for sections.

For beams of heavier sections than those calculated i tables, a separate column of corrections is given for each stating the proper increase of safe load for every addi pound in the weight per foot of beam. The values are based on a maximum fiber stress of 16,000 pound square inch.

It has been assumed in these tables that proper pro is made for preventing the compression flanges of the b from deflecting sideways. They should be held in positi distances not exceeding twenty times the width of the fl otherwise the stress allowed should be reduced as per page 68.

In some instances, *deflection* rather than *absolute str* may become the governing consideration in determinin size of beam to be used. For beams carrying plastered ings, for example, it has been found by practical tests th the deflection exceeds $\frac{1}{360}$ of the distance between sup or $\frac{1}{30}$ of an inch per foot of this distance, there is dang the ceiling cracking.

A table of deflections of Carnegie sections is given on 69. It may generally be assumed both for rolled and

eams that this limit is not exceeded so long as the depth of the eam is not less than $\frac{1}{30}$ of the distance between supports ⅜ in. per foot). This limit is indicated in the following tables y cross lines, beyond which the beams should not be used, if ntended to carry plastered ceilings, unless the allowable loads iven in the tables are reduced. There is an element of safety ot taken into account in the tables, viz., the fact that the dead oad of the floor is carried by the beams before the plaster is pplied; consequently, only the deflection due to the live load s liable to cause damage to the plaster. The following method an be used to obtain the reduced loads:

Multiply the load given immediately above the cross line by the square of the corresponding span and divide by the square of the required span; the result will be the required load. See example III, page 68.

Inasmuch as the carrying capacity of beams increases largely with their depth, and it is therefore economical to use the greatest depth of beam consistent with the other conditions to which it is necessary to conform (as clear height, etc.), the above cases of extreme deflection will rarely be met with in practice.

The tables on pages 81 to 88 inclusive for I-beams give the proper spacing, center to center of beams, for loads varying from 100 to 175 lbs. per square foot and for spans ranging in length from 5 to 30 ft. The spacing of beams is inversely proportioned to the loads; therefore, for a load not given in the table, as, for instance, 200 lbs. per square foot, divide the spaces given for 100 lbs. per square foot by 2, etc.

EXAMPLES

I. What will be the most economical arrangement of fl beams and girders for carrying a load of 150 lbs., includi weight of floor, assuming floor to be supported by brick arcl resting between the beams and carrying a plastered ceili below?

Answer: The spacing of floor beams for brick arches, stated above, should not exceed 6 ft. Referring to pages and 86 we find the *deepest* I-beam corresponding to this spa (above horizontal cross lines) to be a 9 in. I 21.0 lbs. with length of span of 15 feet. The girders to which the floor bea are framed should, therefore, be spaced 15 ft. apart, and fro the table we find that either a 20 in. I 65 lbs. 23 ft. long or 15 in. I 42 lbs. 16 ft. long will answer. By using the form the number of supporting columns will be reduced, but t weight of the girders increased. The relative cost must determined by the circumstances of the case, *i. e.*, length columns, etc. The headroom required may render it necessa to use a double girder of shallower beams, say two 10 i I-beams 25 lbs. 15 ft. long.

II. What size and weight of beam 19 ft. 6 in. long in cle between walls, and, therefore, 20 ft. 0 in. long between cente of supports, will be required to carry safely a uniformly d tributed load of 17 tons, the weight of the beam included?

Answer: From the table of safe loads of I-beams a 15 i I 42 lbs. will carry safely for a span of 20 ft. 15.71 tons, or 1. tons less than required in this case. From the next colum we find that for every pound increase in weight of beam v may add 0.20 tons to the load. Hence, for 1.29 tons we mu increase the weight per foot of beam by 1.29 ÷ .20 = 6.4 lb *i. e.*, the beam required should weigh 42 + 6.4 = 48.4 lbs. v

ot, but as this weight is not rolled the beam to be used ould weigh 50 lbs.

III. What load uniformly distributed, including its own eight, will a 15 in. I-beam weighing 60.0 lbs. per foot carry r a span of 30 ft. without deflecting sufficiently to endanger plastered ceiling?

Answer: From the table for safe loads of I-beams we nd at the limit indicated for plastered ceilings that a 15 in. 0.0 lb. beam will carry safely a uniform load of 17.32 tons ver a span of 25 ft. In order not to give rise to undue de- lection, the safe load for a 30 ft. span, according to the rule given on page 66, will be $\frac{17.32 \times 25^2}{30^2} = 12.03$ tons.

BEAMS WITHOUT LATERAL SUPPORT

Length of Beam	Proportion of Tabular Load Forming Greatest Safe Load
20 times flange width	Whole tabular load
30 " " "	$\frac{9}{10}$ " "
40 " " "	$\frac{8}{10}$ " "
50 " " "	$\frac{7}{10}$ " "
60 " " "	$\frac{6}{10}$ " "
70 " " "	$\frac{5}{10}$ " "

DEFLECTION COEFFICIENTS FOR CARN SHAPES GIVEN IN 64THS OF AN INC

Coefficient Index	Distance between Supports in Feet							
	6	8	10	12	14	16	18	20
C. S.	38.1	67.8	105.9	152.5	207.6	271.2	343.2	423.
C.' S.	29.8	53.0	82.8	119.2	162.2	211.8	268.1	331.

Coefficient Index	Distance between Supports in Feet							
	24	26	28	30	32	34	36	3
C. S.	610.2	716.1	830.5	953.4	1085.0	1225.0	1373.0	15
C.' S.	476.6	559.4	648.8	744.8	847.4	956.6	1073.0	11

Figures given opposite C. S. and C.' S. are the d coefficients for steel shapes, subject to transverse st varying spans under their maximum uniformly distribu loads, derived from a fiber stress of 16,000 and 12,500 ively; the modulus of elasticity being taken at 29,000,0

To find the deflection of any symmetrical shape u beam under its corresponding safe load, divide the coe given in the above tables by the depth of the bean applies to such shapes as I-beams, channels, Z-bars, e those beams having unsymmetrical axes, such as tees, etc., divide by twice the greatest distance of the neu from the outside fiber.

EXAMPLE: Required the deflection of a 12" I-be lbs. 20 ft. span under its maximum uniformly distribu load of 9.59 tons, as given on page 71. The above tab 423.7 as the deflection coefficient; dividing this by 35.3 as the required deflection in 64ths of an inch.

For deflections due to different systems of load *page 94.*

SAFE LOADS UNIFORMLY DISTRIBUTED FOR STANDARD AND SPECIAL I-BEAMS

IN TONS OF 2,000 LBS.

24" I	Add for every lb. increase in weight	20" I		Add for every lb. increase in weight	18" I	Add for every lb. increase in weight	15" I			Add for every lb. increase in weight
80 lbs.		80 lbs.	65 lbs.		55 lbs.		80 lbs.	60 lbs.	42 lbs.	
77.33	.53	65.18	51.98	.44	39.29	.39	47.14	36.09	26.18	.33
71.38	.48	60.16	47.98	.40	36.27	.36	43.51	33.31	24.17	.30
66.28	.45	55.87	44.56	.37	33.68	.34	40.40	30.93	22.44	.28
61.86	.42	52.14	41.59	.35	31.43	.31	37.71	28.87	20.94	.26
58.00	.39	48.88	38.99	.33	29.47	.29	35.35	27.07	19.63	.24
54.58	.37	46.01	36.69	.31	27.74	.28	33.27	25.47	18.48	.23
51.56	.35	43.45	34.66	.29	26.19	.26	31.42	24.06	17.45	.22
48.84	.33	41.17	32.83	.28	24.82	.25	29.77	22.79	16.53	.21
46.40	.32	39.11	31.19	.26	23.58	.24	28.28	21.65	15.71	.20
44.19	.30	37.24	29.70	.25	22.45	.22	26.94	20.62	14.96	.19
42.18	.29	35.55	28.35	.24	21.43	.21	25.71	19.68	14.28	.18
40.35	.27	34.01	27.12	.23	20.50	.20	24.59	18.83	13.66	.17
38.67	.26	32.59	25.99	.22	19.65	.20	23.57	18.04	13.09	.16
37.12	.25	31.29	24.95	.21	18.86	.19	22.63	17.32	12.57	.16
35.69	.24	30.08	23.99	.20	18.14	.18	21.76	16.66	12.08	.15
34.37	.23	28.97	23.10	.19	17.46	.17	20.95	16.04	11.64	.14
33.14	.23	27.93	22.28	.19	16.84	.17	20.20	15.47	11.22	.14
32.00	.22	26.97	21.51	.18	16.26	.16	19.51	14.93	10.83	.13
30.93	.21	26.07	20.79	.17	15.72	16	18.86	14.43	10.47	.13
29.94	.20	25.23	20.12	.17	15.21	.15	18.25	13.97	10.13	.13
29.00	.20	24.44	19.49	.16	14.73	.15	17.68	13.53	9.82	.12
28.12	.19	23.70	18.90	.16	14.29	.14	17.14	13.12	9.52	.12
27.29	.19	23.00	18.35	.15	13.87	.14	16.64	12.74	9.24	.11
26.51	.18	22.35	17.82	.15	13.47	.13	16.16	12.37	8.98	.11
25.78	.18	21.73	17.33	.15	13.10	.13	15.71	12.03	8.73	.11

Safe loads given include weight of beam. Maximum fiber stress, *lbs. per square inch.*

SAFE LOADS UNIFORMLY DISTRIBUTED FOR STANDARD AND SPECIAL I-BEAMS

IN TONS OF 2,000 LBS.

Distance between Supports in Feet	12" I 40 lbs.	12" I 31.5 lbs	Add for every lb. increase in weight	10" I 25 lbs.	Add for every lb. increase in weight	9" I 21 lbs.	Add for every lb. increase in weight	Distance between Supports in Feet	8" I 18 lbs.
12	19.92	15.99	.26	10.85	.22	8.39	.20	5	15.17
13	18.39	14.76	.24	10.02	.20	7.74	.18	6	12.64
14	17.08	13.70	.23	9.30	.19	7.19	.17	7	10.84
15	15.94	12.79	.21	8.68	.17	6.71	.16	8	9.48
16	14.94	11.99	.20	8.14	.16	6.29	.15	9	8.43
17	14.06	11.29	.19	7.66	.15	5.92	.14	10	7.59
18	13.28	10.66	.18	7.24	.14	5.59	.13	11	6.90
19	12.58	10.10	.17	6.86	.14	5.30	.12	12	6.32
20	11.95	9.59	.16	6.51	.13	5.03	.12	13	5.83
21	11.38	9.14	.15	6.20	.12	4.79	.11	14	5.42
22	10.87	8.72	.14	5.92	.12	4.58	.11	15	5.06
23	10.39	8.34	.14	5.66	.11	4.38	.10	16	4.74
24	9.96	7.99	.13	5.43	.11	4.19	.10	17	4.46
25	9.56	7.67	.13	5.21	.10	4.03	.09	18	4.21
26	9.19	7.38	.12	5.01	.10	3.87	.09	19	3.99
27	8.85	7.11	.12	4.82	.10	3.73	.09	20	3.79
28	8.54	6.85	.11	4.65	.09	3.59	.08	21	3.61
29	8.24	6.62	.11	4.49	.09	3.47	.08	....	......
30	7.97	6.40	.11	4.34	.09	3.36	.08	....	......

Safe loads given include weight of beam. Maximum fiber s
16,000 lbs. per square inch.

SAFE LOADS UNIFORMLY DISTRIBUTED FOR STANDARD AND SPECIAL I-BEAMS

IN TONS OF 2,000 LBS.

Distance between Supports in Feet	7" I 15 lbs.	Add for every lb. increase in weight	6" I 12.25 lbs.	Add for every lb. increase in weight	5" I 9.75 lbs.	Add for every lb. increase in weight	4" I 7.5 lbs.	Add for every lb. increase in weight	3" I 5.5 lbs.	Add for every lb. increase in weight
5	11.04	.36	7.75	.31	5.16	.26	3.18	.21	1.76	.16
6	9.20	.30	6.46	.26	4.30	.22	2.65	.18	1.47	.13
7	7.89	.26	5.54	.22	3.69	.19	2.27	.15	1.26	.11
8	6.90	.23	4.84	.19	3.23	.16	1.99	.13	1.10	.10
9	6.13	.20	4.31	.17	2.87	.14	1.77	.12	0.98	.09
10	5.52	.18	3.88	.16	2.58	.13	1.59	.11	0.88	.08
11	5.02	.16	3.52	.14	2.35	.12	1.45	.10	0.80	.07
12	4.60	.15	3.23	.13	2.15	.11	1.33	.09	0.73	.07
13	4.25	.14	2.98	.12	1.98	.10	1.22	.08	0.68	.06
14	3.94	.13	2.77	.11	1.84	.09	1.14	.08	0.63	.06
15	3.68	.12	2.58	.10	1.72	.09	1.06	.07	0.59	.05
16	3.45	.11	2.42	.10	1.61	.08	0.99	.07	0.55	.05
17	3.25	.11	2.28	.09	1.52	.08	0.94	.06	0.52	.05
18	3.07	.10	2.15	.09	1.43	.07	0.88	.06	0.49	.04
19	2.91	.09	2.04	.08	1.36	.07	0.84	.06	0.46	.04
20	2.76	.09	1.94	.08	1.29	.07	0.80	.05	0.44	.04
21	2.63	.09	1.85	.07	1.23	.06	0.76	.05	0.42	.04

Safe loads *given include* weight of beam. Maximum fiber stress, *16,000 lbs. per square inch.*

SAFE LOADS UNIFORMLY DISTRIBUTE
FOR STANDARD AND SPECIAL CHANNELS

IN TONS OF 2,000 LBS.

Distance between Supports in Feet	15″ ⊏ 33 lbs.	Add for every lb. increase in weight	12″ ⊏ 20.5 lbs.	Add for every lb. increase in weight	10″ ⊏ 15 lbs.	Add for every lb. increase in weight	9″ ⊏ 13.25 lbs.
10	22.23	.39	11.39	.32	7.14	.26	5.61
11	20.20	.35	10.35	.29	6.49	.24	5.10
12	18.52	.33	9.49	.26	5.95	.22	4.68
13	17.10	.30	8.76	.24	5.49	.20	4.32
14	15.87	.28	8.14	.23	5.10	.19	4.01
15	14.82	.26	7.59	.21	4.76	.17	3.74
16	13.89	.24	7.12	.20	4.46	.16	3.51
17	13.07	.23	6.70	.18	4.20	.15	3.30
18	12.35	.22	6.33	.18	3.96	.14	3.12
19	11.70	.21	5.99	.17	3.76	.14	2.95
20	11.11	.20	5.70	.16	3.57	.13	2.81
21	10.58	.19	5.42	.15	3.40	.12	2.67
22	10.10	.18	5.18	.14	3.24	.12	2.55
23	9.66	.17	4.95	.14	3.10	.11	2.44
24	9.26	.16	4.75	.13	2.97	.11	2.34
25	8.89	.16	4.56	.13	2.85	.10	2.24
26	8.55	.15	4.38	.12	2.74	.10	2.16
27	8.23	.14	4.22	.12	2.64	.10	2.08
28	7.94	.14	4.07	.11	2.55	.09	2.00
29	7.66	.13	3.93	.11	2.46	.09	1.93
30	7.41	.13	3.80	.11	2.38	.09	1.87

Safe loads given include weight of channel. Maximum fibe 16,000 lbs. per square inch.

SAFE LOADS UNIFORMLY DISTRIBUTED FOR STANDARD AND SPECIAL CHANNELS

IN TONS OF 2,000 LBS.

Supports in Feet	8" ⊏ 11.25 lbs.	Add for every lb. increase in weight	7" ⊏ 9.75 lbs.	Add for every lb. increase in weight	6" ⊏ 8 lbs.	Add for every lb. increase in weight	5" ⊏ 6.5 lbs.	Add for every lb. increase in weight	4" ⊏ 5.25 lbs.	Add for every lb. increase in weight	3" ⊏ 4 lbs.	Add for every lb. increase in weight
5	8.61	.42	6.68	.36	4.62	.31	3.16	.26	2.02	.21	1.16	.16
6	7.18	.35	5.57	.30	3.85	.26	2.63	.22	1.68	.18	.97	.13
7	6.15	.30	4.77	.26	3.30	.22	2.26	.19	1.44	.15	.83	.11
8	5.38	.26	4.18	.23	2.89	.19	1.98	.16	1.26	.13	.73	.10
9	4.78	.23	3.71	.20	2.57	.17	1.76	.14	1.12	.12	.64	.09
10	4.31	.21	3.34	.18	2.31	.16	1.58	.13	1.01	.11	.58	.08
11	3.91	.19	3.04	.16	2.10	.14	1.44	.12	.92	.10	.53	.07
12	3.59	.18	2.78	.15	1.93	.13	1.32	.11	.84	.09	.48	.07
13	3.31	.16	2.57	.14	1.78	.12	1.22	.10	.78	.08	.45	.06
14	3.08	.15	2.39	.13	1.65	.11	1.13	.09	.72	.08	.41	.06
15	2.87	.14	2.23	.12	1.54	.10	1.05	.09	.67	.07	.39	.05
16	2.69	.13	2.09	.11	1.44	.10	.99	.08	.63	.07	.36	.05
17	2.53	.12	1.96	.11	1.36	.09	.93	.08	.59	.06	.34	.05
18	2.39	.11	1.86	.10	1.28	.09	.88	.07	.56	.06	.32	.04
19	2.27	.11	1.76	.09	1.22	.08	.83	.07	.53	.06	.31	.04
20	2.15	.11	1.67	.09	1.16	.08	.79	.07	.51	.05	.29	.04
21	2.05	.10	1.59	.09	1.10	.07	.75	.06	.48	.05	.28	.04
22	1.96	.10	1.52	.08	1.05	.07	.72	.06	.46	.05	.26	.04
23	1.87	.09	1.45	.08	1.00	.07	.69	.06	.44	.05	.25	.03
24	1.79	.09	1.39	.08	.96	.06	.66	.05	.42	.04	.24	.03
25	1.72	.08	1.34	.07	.92	.06	.63	.05	.40	.04	.23	.03

Safe loads given include weight of channel. Maximum fiber stress, ,000 *lbs. per square inch.*

SAFE LOADS IN TONS OF 2,000 LBS. UNIFORMLY DISTRIBUTED FOR STANDARD Z-BARS

Size Inches	Thickness of Metal	Distance between Supports in Feet									
		4	5	6	7	8	9	10	12	14	16
6	3/8	11.25	9.00	7.50	6.43	5.63	5.00	4.50	3.75	3.21	2.81
6 1/16	7/16	13.11	10.48	8.73	7.48	6.55	5.82	5.24	4.37	3.74	3.28
6 1/8	1/2	14.96	11.97	9.97	8.55	7.48	6.65	5.99	4.99	4.28	3.74
6	9/16	15.40	12.32	10.27	8.80	7.70	6.84	6.16	5.13	4.40	3.85
6 1/16	5/8	17.09	13.67	11.40	9.76	8.55	7.60	6.84	5.70	4.88	4.27
6 1/8	11/16	18.80	15.04	12.53	10.74	9.40	8.36	7.52	6.27	5.37	4.70
6	3/4	18.72	14.98	12.48	10.70	9.36	8.32	7.49	6.24	5.35	4.68
6 1/16	13/16	20.29	16.23	13.53	11.59	10.15	9.02	8.12	6.76	5.80	5.07
6 1/8	7/8	21.86	17.49	14.57	12.49	10.93	9.72	8.75	7.29	6.25	5.47
5	5/16	7.12	5.70	4.75	4.07	3.56	3.17	2.85	2.37	2.03	1.78
5 1/16	3/8	8.52	6.82	5.68	4.87	4.26	3.79	3.41	2.84	2.43	2.13
5 1/8	7/16	9.92	7.94	6.62	5.67	4.96	4.41	3.97	3.31	2.83	2.48
5	1/2	10.24	8.19	6.83	5.85	5.12	4.55	4.09	3.41	2.92	2.56
5 1/16	9/16	11.49	9.19	7.66	6.56	5.75	5.11	4.60	3.83	3.28	2.87
5 1/8	5/8	12.76	10.21	8.51	7.29	6.38	5.67	5.11	4.25	3.65	3.19
5	11/16	12.63	10.10	8.42	7.21	6.32	5.61	5.05	4.21	3.61	3.16
5 1/16	3/4	13.79	11.03	9.19	7.88	6.89	6.13	5.52	4.60	3.94	3.45
5 1/8	13/16	14.94	11.95	9.96	8.54	7.47	6.64	5.97	4.98	4.27	3.73
4	1/4	4.19	3.35	2.79	2.39	2.09	1.86	1.68	1.40	1.20	1.05
4 1/16	5/16	5.21	4.17	3.48	2.98	2.60	2.32	2.08	1.74	1.49	1.30
4 1/8	3/8	6.22	4.98	4.15	3.56	3.11	2.77	2.49	2.08	1.78	1.56
4	7/16	6.44	5.15	4.29	3.68	3.22	2.86	2.57	2.15	1.84	1.61
4 1/16	1/2	7.33	5.87	4.89	4.19	3.67	3.26	2.93	2.44	2.09	1.83
4 1/8	9/16	8.24	6.59	5.49	4.71	4.12	3.66	3.29	2.75	2.35	2.06
4	5/8	8.06	6.45	5.37	4.61	4.03	3.58	3.23	2.69	2.31	2.01
4 1/16	11/16	8.86	7.09	5.91	5.06	4.43	3.95	3.55	2.96	2.53	2.21
4 1/8	3/4	9.68	7.74	6.45	5.53	4.84	4.30	3.87	3.23	2.76	2.42
3	1/4	2.56	2.05	1.71	1.46	1.28	1.14	1.03	0.85	0.73	0.64
3 1/16	5/16	3.17	2.54	2.12	1.81	1.58	1.41	1.27	1.06	0.91	0.79
3	3/8	3.44	2.74	2.28	1.96	1.72	1.52	1.37	1.14	0.98	0.86
3 1/16	7/16	3.97	3.18	2.65	2.27	1.98	1.77	1.59	1.32	1.13	0.99
3	1/2	4.08	3.26	2.72	2.33	2.04	1.81	1.63	1.36	1.17	1.02
3 1/16	9/16	4.57	3.66	3.05	2.62	2.28	2.03	1.83	1.52	1.31	1.14

Safe loads given include weight of Z-bar. Maximum fiber stress, 16,000 lbs. per square inch.

.OADS IN TONS OF 2,000 LBS. UNIFORMLY 'RIBUTED FOR STANDARD AND SPECIAL ANGLES WITH EQUAL LEGS

gle	Distance between Supports in Feet									
	1	2	3	4	5	6	7	8	9	10
× 1 1/8	93.49	46.74	31.16	23.37	18.70	15.58	13.36	11.69	10.39	9.35
× 1/2	44.64	22.32	14.88	11.16	8.93	7.44	6.38	5.58	4.96	4.46
× 1	45.72	22.86	15.24	11.43	9.14	7.62	6.53	5.72	5.08	4.57
× 3/8	18.82	9.41	6.27	4.70	3.76	3.14	2.69	2.35	2.09	1.88
× 1	30.91	15.45	10.30	7.73	6.18	5.15	4.42	3.86	3.43	3.09
× 3/8	12.91	6.45	4.30	3.23	2.58	2.15	1.84	1.61	1.43	1.29
× 13/16	16.05	8.03	5.35	4.01	3.21	2.68	2.29	2.01	1.78	1.61
× 5/16	6.88	3.44	2.29	1.72	1.38	1.15	0.98	0.86	0.76	0.69
× 11/16	12.00	6.00	4.00	3.00	2.40	2.00	1.71	1.50	1.33	1.20
× 5/16	5.20	2.60	1.73	1.30	1.04	0.87	0.74	0.65	0.58	0.52
× 5/8	6.93	3.47	2.31	1.73	1.39	1.16	0.99	0.87	0.77	0.69
× 1/4	3.09	1.55	1.03	0.77	0.62	0.52	0.44	0.39	0.34	0.31
× 1/2	4.75	2.37	1.58	1.19	0.95	0.79	0.68	0.59	0.53	0.47
× 1/4	2.56	1.28	0.85	0.64	0.51	0.43	0.37	0.32	0.28	0.26
× 1/2	3.89	1.95	1.29	0.97	0.78	0.65	0.56	0.49	0.43	0.39
× 3/16	1.61	0.81	0.54	0.40	0.32	0.27	0.23	0.20	0.18	0.16
× 1/2	3.09	1.55	1.03	0.77	0.62	0.52	0.44	0.39	0.34	0.31
× 3/16	1.30	0.65	0.43	0.32	0.26	0.22	0.19	0.16	0.14	0.13
× 7/16	2.13	1.07	0.71	0.53	0.43	0.36	0.30	0.27	0.24	0.21
× 3/16	1.01	0.51	0.34	0.25	0.20	0.17	0.14	0.13	0.11	0.10
× 7/16	1.60	0.80	0.53	0.40	0.32	0.27	0.23	0.20	0.18	0.16
× 3/16	0.75	0.37	0.25	0.19	0.15	0.12	0.11	0.093	0.083	0.075
× 3/8	1.01	0.51	0.34	0.25	0.20	0.17	0.14	0.130	0.110	0.100
× 1/8	0.38	0.19	0.13	0.096	0.077	0.064	0.055	0.048	0.043	0.038
× 5/16	0.58	0.29	0.19	0.150	0.120	0.097	0.083	0.073	0.065	0.058
× 1/8	0.26	0.13	0.087	0.065	0.052	0.044	0.037	0.033	0.029	0.026
× 1/4	0.30	0.15	0.100	0.075	0.060	0.050	0.043	0.037	0.033	0.030
× 1/8	0.17	0.083	0.055	0.041	0.033	0.028	0.024	0.021	0.018	0.017
× 3/16	0.18	0.088	0.059	0.044	0.035	0.029	0.025	0.022	0.020	0.018
× 1/8	0.12	0.061	0.041	0.031	0.025	0.020	0.018	0.015	0.014	0.012
× 3/16	0.13	0.064	0.043	0.032	0.026	0.021	0.018	0.016	0.014	0.013
× 1/8	0.091	0.045	0.030	0.023	0.018	0.015	0.013	0.011	0.010	0.009

loads given include weight of angle. Maximum fiber stress, s. per square *inch*. Neutral axis through center of gravity *o one leg*. Angles marked * are special.

SAFE LOADS IN TONS OF 2,000 LBS. UNIF
DISTRIBUTED FOR STANDARD AND SPE
ANGLES WITH UNEQUAL LEGS

LONG LEG VERTICAL

Size of Angle	Distance between Supports in Feet							
	1	2	3	4	5	6	7	8
*8 x3½x $\frac{11}{20}$	42.59	21.29	14.20	10.65	8.52	7.10	6.08	5.3[illegible]
*7 x3½x1	56.43	28.21	18.81	14.11	11.29	9.40	8.06	7.0[illegible]
*7 x3½x $\frac{7}{16}$	26.72	13.36	8.91	6.68	5.34	4.45	3.82	3.3[illegible]
6 x4 x1	42.77	21.39	14.26	10.69	8.55	7.13	6.11	5.3[illegible]
6 x4 x ⅜	17.71	8.85	5.90	4.43	3.54	2.95	2.53	2.21
6 x3½x1	41.76	20.88	13.92	10.44	8.35	6.96	5.97	5.2[illegible]
6 x3½x ⅜	17.33	8.67	5.78	4.33	3.47	2.89	2.48	2.1[illegible]
*5 x4 x ⅞	26.61	13.31	8.87	6.65	5.32	4.44	3.80	3.3[illegible]
*5 x4 x ⅜	12.48	6.24	4.16	3.12	2.50	2.08	1.78	1.5[illegible]
5 x3½x ⅞	26.03	13.01	8.68	6.51	5.21	4.34	3.72	3.2[illegible]
5 x3½x $\frac{5}{16}$	10.35	5.18	3.45	2.59	2.07	1.73	1.48	1.2[illegible]
5 x3 x $\frac{13}{16}$	23.73	11.87	7.91	5.93	4.75	3.96	3.39	2.9[illegible]
5 x3 x $\frac{5}{16}$	10.08	5.04	3.36	2.52	2.02	1.68	1.44	1.2[illegible]
*4½x3 x $\frac{13}{16}$	19.31	9.65	6.44	4.83	3.86	3.22	2.76	2.41
*4½x3 x $\frac{5}{16}$	8.21	4.11	2.74	2.05	1.64	1.37	1.17	1.0[illegible]
*4 x3½x $\frac{13}{16}$	15.57	7.79	5.19	3.89	3.11	2.60	2.22	1.9[illegible]
*4 x3½x $\frac{5}{16}$	6.72	3.36	2.24	1.68	1.34	1.12	0.96	0.84
4 x3 x $\frac{13}{16}$	15.31	7.65	5.10	3.83	3.06	2.55	2.19	1.91
4 x3 x $\frac{5}{16}$	6.56	3.28	2.19	1.64	1.31	1.10	0.94	0.8[illegible]
3½x3 x $\frac{13}{16}$	11.73	5.87	3.91	2.93	2.35	1.96	1.68	1.4[illegible]
3½x3 x $\frac{5}{16}$	5.12	2.56	1.71	1.28	1.02	0.85	0.73	0.64
3½x2½x $\frac{11}{16}$	9.87	4.93	3.29	2.47	1.97	1.64	1.41	1.2[illegible]
3½x2½x ¼	4.00	2.00	1.33	1.00	0.80	0.67	0.57	0.5[illegible]
*3¼x2 x $\frac{9}{16}$	6.93	3.47	2.31	1.73	1.39	1.16	0.99	0.8[illegible]
*3¼x2 x ¼	3.36	1.68	1.12	0.84	0.67	0.56	0.48	0.4[illegible]
3 x2½x $\frac{9}{16}$	6.13	3.07	2.04	1.53	1.23	1.02	0.88	0.7[illegible]
3 x2½x ¼	2.99	1.50	1.00	0.75	0.60	0.50	0.43	0.3[illegible]
*3 x2 x ½	5.33	2.67	1.78	1.33	1.07	0.89	0.76	0.6[illegible]
*3 x2 x ¼	2.88	1.44	0.96	0.72	0.58	0.48	0.41	0.3[illegible]
2½x2 x ½	3.73	1.87	1.24	0.93	0.75	0.62	0.53	0.4[illegible]
2½x2 x $\frac{3}{16}$	1.55	0.77	0.52	0.39	0.31	0.26	0.22	0.1[illegible]
*2¼x1½x ½	2.87	1.43	0.96	0.72	0.57	0.48	0.41	0.3[illegible]
*2¼x1½x $\frac{3}{16}$	1.23	0.61	0.41	0.31	0.25	0.21	0.18	0.1[illegible]
*2 x1⅜x ¼	1.23	0.61	0.41	0.31	0.25	0.21	0.18	0.1[illegible]
*2 x1⅜x $\frac{3}{16}$	0.96	0.48	0.32	0.24	0.19	0.16	0.14	0.12
*1⅜x1 x ¼	0.48	0.24	0.16	0.12	0.10	0.08	0.07	0.0[illegible]
*1⅜x1 x ⅛	0.32	0.16	0.11	0.08	0.06	0.05	0.05	0.04

Safe loads given include weight of angle. Maximum fi
16,000 lbs. per square inch. Neutral axis through center
parallel to short leg. Angles marked * are special.

SAFE LOADS IN TONS OF 2,000 LBS. UNIFORMLY DISTRIBUTED FOR STANDARD AND SPECIAL ANGLES WITH UNEQUAL LEGS

SHORT LEG VERTICAL

Size of Angle	Distance between Supports in Feet									
	1	2	3	4	5	6	7	8	9	10
*8 x3½ x 11/20	9.53	4.76	3.18	2.38	1.91	1.59	1.36	1.19	1.06	0.95
*7 x3½ x1	15.79	7.89	5.26	3.95	3.16	2.63	2.26	1.97	1.75	1.58
*7 x3½ x 7/16	7.84	3.92	2.61	1.96	1.57	1.31	1.12	0.98	0.87	0.78
6 x4 x1	20.21	10.11	6.74	5.05	4.04	3.37	2.89	2.53	2.25	2.02
6 x4 x ⅜	8.53	4.27	2.84	2.13	1.71	1.42	1.22	1.07	0.95	0.85
6 x3½ x1	15.47	7.74	5.16	3.87	3.09	2.58	2.21	1.93	1.72	1.55
6 x3½ x ⅜	6.56	3.28	2.19	1.64	1.31	1.09	0.94	0.82	0.73	0.66
*5 x4 x ⅞	17.65	8.83	5.88	4.41	3.53	2.94	2.52	2.21	1.96	1.77
*5 x4 x ⅜	8.37	4.19	2.79	2.09	1.67	1.40	1.20	1.05	0.93	0.84
5 x3½ x ⅞	13.44	6.72	4.48	3.36	2.69	2.24	1.92	1.68	1.49	1.34
5 x3½ x 5/16	5.44	2.72	1.81	1.36	1.09	0.91	0.78	0.68	0.60	0.54
5 x3 x 13/16	9.28	4.64	3.09	2.32	1.86	1.55	1.33	1.16	1.03	0.93
5 x3 x 5/16	4.00	2.00	1.33	1.00	0.80	0.67	0.57	0.50	0.44	0.40
*4½ x3 x 13/16	9.12	4.56	3.04	2.28	1.82	1.52	1.30	1.14	1.01	0.91
*4½ x3 x 5/16	4.05	2.03	1.35	1.01	0.81	0.68	0.58	0.51	0.45	0.41
*4 x3½ x 13/16	12.27	6.13	4.09	3.07	2.45	2.05	1.75	1.53	1.36	1.23
*4 x3½ x 5/16	5.39	2.69	1.80	1.35	1.08	0.90	0.77	0.67	0.60	0.54
4 x3 x 13/16	8.96	4.48	2.99	2.24	1.79	1.49	1.28	1.12	1.00	0.90
4 x3 x 5/16	3.95	1.97	1.32	0.99	0.79	0.66	0.56	0.49	0.44	0.39
3½ x3 x 13/16	8.80	4.40	2.93	2.20	1.76	1.47	1.26	1.10	0.98	0.88
3½ x3 x 5/16	3.84	1.92	1.28	0.96	0.77	0.64	0.55	0.48	0.43	0.38
3½ x2½ x 11/16	5.28	2.64	1.76	1.32	1.06	0.88	0.75	0.66	0.59	0.53
3½ x2½ x ¼	2.19	1.09	0.73	0.55	0.44	0.36	0.31	0.27	0.24	0.22
*3¼ x2 x 9/16	2.83	1.41	0.94	0.71	0.57	0.47	0.40	0.35	0.31	0.28
*3¼ x2 x ¼	1.39	0.69	0.46	0.35	0.28	0.23	0.20	0.17	0.15	0.14
3 x2½ x 9/16	4.37	2.19	1.46	1.09	0.87	0.73	0.62	0.55	0.49	0.44
3 x2½ x ¼	2.13	1.07	0.71	0.53	0.43	0.36	0.30	0.27	0.24	0.21
*3 x2 x ½	2.51	1.25	0.84	0.63	0.50	0.42	0.36	0.31	0.28	0.25
*3 x2 x ¼	1.33	0.67	0.44	0.33	0.27	0.22	0.19	0.17	0.15	0.13
2½ x2 x ½	2.45	1.23	0.82	0.61	0.49	0.41	0.35	0.31	0.27	0.25
2½ x2 x 3/16	1.07	0.53	0.36	0.27	0.21	0.18	0.15	0.13	0.12	0.11
*2¼ x1½ x ½	1.39	0.69	0.46	0.35	0.28	0.23	0.20	0.17	0.15	0.14
*2¼ x1½ x 3/16	0.59	0.29	0.20	0.15	0.12	0.10	0.08	0.07	0.07	0.06
*2 x1⅜ x ¼	0.64	0.32	0.21	0.16	0.13	0.11	0.09	0.08	0.07	0.06
*2 x1⅜ x 3/16	0.48	0.24	0.16	0.12	0.10	0.08	0.07	0.06	0.05	0.05
*1⅜ x1 x ¼	0.27	0.13	0.09	0.07	0.05	0.04	0.04	0.03	0.03	0.03
*1⅜ x1 x ⅛	0.16	0.08	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02

Safe loads given include weight of angle. Maximum fiber stress, 16,000 lbs. *per square inch.* Neutral axis through center of gravity *parallel to long leg.* Angles marked * are special.

SAFE LOADS IN TONS OF 2,000 LBS. UNIFO DISTRIBUTED FOR CARNEGIE TEES

Size Flange by Stem	Weight per Foot	Distance between Supports in Feet								
		1	2	3	4	5	6	7	8	9
5 x 3	13.6	6.29	3.15	2.10	1.57	1.26	1.05	0.90	0.79	0.
5 x 2½	11.0	4.59	2.29	1.53	1.15	0.92	0.76	0.66	0.57	0.
4½ x 3½	15.9	11.36	5.68	3.79	2.84	2.27	1.89	1.62	1.42	1.
4½ x 3	8.6	4.32	2.16	1.44	1.08	0.86	0.72	0.62	0.54	0.
4½ x 3	10.0	5.01	2.51	1.67	1.25	1.00	0.84	0.72	0.63	0.
4½ x 2½	8.0	2.99	1.49	0.96	0.75	0.60	0.48	0.43	0.37	0.
4½ x 2½	9.3	3.47	1.73	1.16	0.87	0.69	0.58	0.50	0.43	0.
4 x 5	15.7	16.53	8.27	5.51	4.13	3.31	2.76	2.36	2.07	1.
4 x 5	12.3	12.96	6.48	4.32	3.24	2.59	2.16	1.85	1.62	1.
4 x 4½	14.8	13.60	6.80	4.53	3.40	2.72	2.27	1.94	1.70	1.
4 x 4½	11.6	10.56	5.28	3.52	2.64	2.11	1.76	1.51	1.32	1.
4 x 4	13.9	10.77	5.39	3.59	2.69	2.15	1.80	1.54	1.35	1.
4 x 4	10.9	8.75	4.37	2.92	2.19	1.75	1.46	1.25	1.09	0.
4 x 3	9.3	4.69	2.35	1.56	1.17	0.94	0.78	0.67	0.59	0.
4 x 2½	8.7	3.31	1.65	1.10	0.83	0.66	0.55	0.47	0.41	0.
4 x 2½	7.4	2.93	1.47	0.98	0.73	0.59	0.49	0.42	0.37	0.
4 x 2	7.9	2.13	1.07	0.71	0.53	0.43	0.36	0.30	0.27	0.
4 x 2	6.7	1.81	0.91	0.60	0.45	0.36	0.30	0.26	0.23	0.
3½ x 4	12.8	10.56	5.28	3.52	2.64	2.11	1.76	1.51	1.32	1.
3½ x 4	10.0	8.27	4.13	2.76	2.07	1.65	1.38	1.18	1.03	0.
3½ x 3½	11.9	8.11	4.05	2.70	2.03	1.62	1.35	1.16	1.01	0.
3½ x 3½	9.3	6.35	3.17	2.12	1.59	1.27	1.06	0.91	0.79	0.
3½ x 3	11.0	6.03	3.01	2.01	1.51	1.21	1.00	0.86	0.75	0.
3½ x 3	8.7	4.69	2.35	1.56	1.17	0.94	0.78	0.67	0.59	0.
3½ x 3	7.7	3.84	1.92	1.28	0.96	0.77	0.64	0.55	0.48	0.
3 x 4	11.9	10.35	5.17	3.45	2.59	2.07	1.72	1.48	1.29	1.
3 x 4	10.6	9.49	4.75	3.16	2.37	1.90	1.58	1.36	1.19	1.
3 x 4	9.3	8.37	4.19	2.79	2.09	1.67	1.40	1.20	1.05	0.
3 x 3½	11.0	7.95	3.97	2.65	1.99	1.59	1.32	1.14	0.99	0.
3 x 3½	9.8	7.31	3.65	2.44	1.83	1.46	1.22	1.04	0.91	0.
3 x 3½	8.6	6.45	3.23	2.15	1.61	1.29	1.08	0.92	0.81	0.
3 x 3	10.1	5.87	2.93	1.96	1.47	1.17	0.98	0.84	0.73	0.

Safe loads given include weight of tee. Maximum fiber
16,000 lbs. per square inch.

E LOADS IN TONS OF 2,000 LBS. UNIFORMLY DISTRIBUTED FOR CARNEGIE TEES

e ge em	Weight per Foot	Distance between Supports in Feet									
		1	2	3	4	5	6	7	8	9	10
3	9.0	5.39	2.69	1.80	1.35	1.08	0.90	0.77	0.67	0.60	0.54
3	7.9	4.59	2.29	1.53	1.15	0.92	0.76	0.66	0.57	0.51	0.46
3	6.8	3.95	1.97	1.32	0.99	0.79	0.66	0.56	0.49	0.44	0.39
2½	7.2	3.20	1.60	1.07	0.80	0.64	0.53	0.46	0.40	0.36	0.32
2½	6.2	2.77	1.39	0.92	0.69	0.55	0.46	0.40	0.35	0.31	0.28
2	7.4	4.00	2.00	1.33	1.00	0.80	0.67	0.57	0.50	0.44	0.40
3	7.2	4.64	2.32	1.55	1.16	0.93	0.77	0.66	0.58	0.52	0.46
3	6.2	4.05	2.03	1.35	1.01	0.81	0.68	0.58	0.51	0.45	0.41
2¾	6.8	3.89	1.95	1.30	0.97	0.78	0.65	0.56	0.49	0.43	0.39
2¾	5.9	3.20	1.60	1.07	0.80	0.64	0.53	0.46	0.40	0.36	0.32
2½	6.5	3.15	1.57	1.05	0.79	0.63	0.52	0.45	0.39	0.35	0.31
2½	5.6	2.67	1.33	0.89	0.67	0.53	0.44	0.38	0.33	0.30	0.27
1¼	3.0	0.48	0.24	0.16	0.12	0.10	0.08	0.07	0.06	0.05	0.05
2¼	5.0	2.24	1.12	0.75	0.56	0.45	0.37	0.32	0.28	0.25	0.22
2¼	4.2	1.71	0.85	0.57	0.43	0.34	0.28	0.24	0.21	0.19	0.17
2	4.4	1.76	0.88	0.59	0.44	0.35	0.29	0.25	0.22	0.20	0.18
2	3.7	1.33	0.67	0.44	0.33	0.27	0.22	0.19	0.17	0.15	0.13
1½	3.2	0.80	0.40	0.27	0.20	0.16	0.13	0.11	0.10	0.09	0.08
1¾	3.2	1.01	0.51	0.34	0.25	0.20	0.17	0.14	0.13	0.11	0.10
1¼	3.7	0.80	0.40	0.27	0.20	0.16	0.13	0.11	0.10	0.09	0.08
1½	2.6	0.75	0.37	0.25	0.19	0.15	0.12	0.11	0.09	0.08	0.07
1½	2.0	0.59	0.29	0.20	0.15	0.12	0.10	0.08	0.07	0.07	0.06
1¼	2.1	0.53	0.27	0.18	0.13	0.11	0.09	0.08	0.07	0.06	0.05
1¼	1.7	0.37	0.19	0.12	0.09	0.07	0.06	0.05	0.05	0.04	0.04
1	1.3	0.27	0.13	0.09	0.07	0.05	0.04	0.04	0.03	0.03	0.03
1	1.0	0.16	0.08	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02

afe loads given include weight of tee. Maximum fiber stress, *lbs. per square inch.*

SPACING OF STANDARD I-BEAMS FOR UNIFORM LOAD OF 100 LBS. PER SQUARE FOOT

PROPER DISTANCE IN FEET CENTER TO CENTER OF BEAM

Distance between Supports in Feet	24″ I	20″ I		18″ I	15″ I			12″ I	
	80 lbs.	80 lbs.	65 lbs.	55 lbs.	80 lbs.	60 lbs.	42 lbs.	40 lbs.	31.5 lbs.
12	128.9	108.6	86.6	65.5	78.6	60.1	43.6	33.2	26.6
13	109.8	92.6	73.8	55.8	67.0	51.3	37.2	28.3	22.7
14	94.7	79.8	63.7	48.1	57.7	44.2	32.1	24.4	19.6
15	82.5	69.5	55.5	41.9	50.3	38.5	27.9	21.3	17.1
16	72.5	61.1	48.7	36.8	44.2	33.8	24.5	18.7	15.0
17	64.2	54.1	43.2	32.6	39.2	30.0	21.7	16.5	13.3
18	57.3	48.3	38.5	29.1	34.9	26.7	19.4	14.8	11.8
19	51.4	43.3	34.6	26.1	31.3	24.0	17.4	13.2	10.6
20	46.4	39.1	31.2	23.6	28.3	21.7	15.7	12.0	9.6
21	42.1	35.5	28.3	21.4	25.7	19.6	14.2	10.8	8.7
22	38.4	32.3	25.8	19.5	23.4	17.9	13.0	9.9	7.9
23	35.1	29.6	23.6	17.8	21.4	16.4	11.9	9.0	7.3
24	32.2	27.2	21.7	16.4	19.6	15.0	10.9	8.3	6.7
25	29.7	25.0	20.0	15.1	18.1	13.9	10.1	7.7	6.1
26	27.5	23.1	18.5	13.9	16.7	12.8	9.3	7.1	5.7
27	25.5	21.5	17.1	12.9	15.5	11.9	8.6	6.6	5.3
28	23.7	20.0	15.9	12.0	14.4	11.0	8.0	6.1	4.9
29	22.1	18.6	14.8	11.2	13.5	10.3	7.5	5.7	4.6
30	20.6	17.4	13.9	10 5	12.6	9.6	7.0	5.3	4.3

For load of 200 lbs. per square foot divide the spacing given b

Maximum fiber stress, 16,000 lbs. per square inch.

SPACING OF STANDARD I-BEAMS FOR UNIFORM LOAD OF 100 LBS. PER SQUARE FOOT

PROPER DISTANCE IN FEET CENTER TO CENTER OF BEAMS

Distance between Supports in Feet	9" I	8" I	7" I	6" I	5" I	4" I	3" I
	21 lbs.	18 lbs.	15 lbs.	12.25 lbs.	9.75 lbs.	7.5 lbs.	5.5 lbs.
5	80.5	60.7	44.2	31.0	20.6	12.7	7.0
6	55.9	42.1	30.7	21.5	14.3	8.8	4.9
7	41.1	31.0	22.5	15.8	10.5	6.5	3.6
8	31.5	23.7	17.3	12.1	8.1	5.0	2.8
9	24.9	18.7	13.6	9.6	6.4	3.9	2.2
10	20.1	15.2	11.1	7.8	5.2	3.2	1.8
11	16.6	12.5	9.1	6.4	4.3	2.6	1.5
12	14.0	10.5	7.7	5.4	3.6	2.2	1.2
13	11.9	9.0	6.5	4.6	3.1	1.9	1.0
14	10.3	7.7	5.6	4.0	2.6	1.6	0.9
15	9.0	6.7	4.9	3.4	2.3	1.4	
16	7.9	5.9	4.3	3.0	2.0	1.2	
17	7.0	5.3	3.8	2.7	1.8	1.1	
18	6.2	4.7	3.4	2.4	1.6	.98	
19	5.6	4.2	3.1	2.2	1.4		
20	5.0	3.8	2.8	1.9	1.3		
21	4.6	3.4	2.5	1.8	1.2		
22	3.8	3.1	2.3	1.6	1.1		

For load of 200 lbs. per square foot divide the spacing given by 2.
Maximum fiber stress, 16,000 lbs. per square inch.

SPACING OF STANDARD I-BEAMS FOR UNIFORM LOAD OF 125 LBS. PER SQUARE FOOT

PROPER DISTANCE IN FEET CENTER TO CENTER OF BEAMS

Distance between Supports in Feet	24" I	20" I		18" I	15" I			12" I		10"
	80 lbs.	80 lbs.	65 lbs.	55 lbs.	80 lbs.	60 lbs.	42 lbs.	40 lbs.	31.5 lbs.	25 lbs.
12	103.1	86.9	69.3	52.4	62.9	48.1	34.9	26.6	21.3	14.5
13	87.8	74.1	59.0	44.6	53.6	41.0	29.8	22.6	18.2	12.3
14	75.8	63.8	51.0	38.5	46.2	35.4	25.7	19.5	15.7	10.6
15	66.0	55.6	44.4	33.5	40.2	30.8	22.3	17.0	13.7	9.3
16	58.0	48.9	39.0	29.5	35.4	27.0	19.6	15.0	12.0	8.2
17	51.4	43.3	34.6	26.1	31.4	24.0	17.4	13.2	10.6	7.2
18	45.8	38.6	30.8	23.3	27.9	21.4	15.5	11.8	9.4	6.4
19	41.1	34.6	27.7	20.9	25.0	19.2	13.9	10.6	8.5	5.8
20	37.1	31.3	25.0	18.9	22.6	17.4	12.6	9.6	7.7	5.2
21	33.7	28.4	22.6	17.1	20.6	15.7	11.4	8.6	7.0	4.7
22	30.7	25.8	20.6	15.6	18.7	14.3	10.4	7.9	6.3	4.3
23	28.1	23.7	18.9	14.3	17.1	13.1	9.5	7.2	5.8	3.9
24	25.8	21.8	17.4	13.1	15.7	12.0	8.7	6.6	5.4	3.6
25	23.8	20.0	16.0	12.1	14.5	11.1	8.1	6.2	4.9	3.4
26	22.0	18.5	14.8	11.2	13.4	10.2	7.4	5.7	4.6	3.1
27	20.4	17.2	13.7	10.3	12.4	9.5	6.9	5.3	4.2	2.9
28	19.0	16.0	12.7	9.6	11.5	8.8	6.4	4.9	3.9	2.6
29	17.7	14.9	11.8	9.0	10.8	8.2	6.0	4.6	3.7	2.5
30	16.5	13.9	11.1	8.4	10.1	7.7	5.6	4.2	3.4	2.3

For load of 250 lbs. per square foot divide the spacing given by
Maximum fiber stress, 16,000 lbs. per square inch.

SPACING OF STANDARD I-BEAMS FOR UNIFORM LOAD OF 125 LBS. PER SQUARE FOOT

PROPER DISTANCE IN FEET CENTER TO CENTER OF BEAMS

9" I	8" I	7" I	6" I	5" I	4" I	3" I
21 lbs.	18 lbs.	15 lbs.	12.25 lbs.	9.75 lbs.	7.5 lbs.	5.5 lbs.
64.4	48.6	35.4	24.8	16.5	10.2	5.6
44.7	33.7	24.6	17.2	11.4	7.1	3.9
32.9	24.8	18.0	12.6	8.4	5.2	2.9
25.2	19.0	13.8	9.7	6.4	4.0	2.2
19.9	15.0	10.9	7.7	5.1	3.2	1.7
16.1	12.2	8.9	6.2	4.1	2.5	1.4
13.8	10.0	7.3	5.1	3.4	2.1	1.2
11.2	8.4	6.1	4.3	2.9	1.8	1.0
9.5	7.2	5.2	3.7	2.4	1.5	0.8
8.2	6.2	4.5	3.2	2.1	1.3	
7.2	5.4	3.9	2.8	1.8	1.1	
6.3	4.7	3.4	2.4	1.6	1.0	
5.6	4.2	3.1	2.1	1.4		
5.0	3.7	2.7	1.9	1.3		
4.5	3.4	2.4	1.7	1.1		
4.0	3.0	2.2	1.6	1.0		
3.7	2.8	2.0	1.4	0.9		
3.3	2.5	1.8	1.3			

For load *of 250 lbs. per* square foot divide the spacing given by 2.
ximum fiber stress, 16,000 lbs. per square inch.

SPACING OF STANDARD I-BEAMS FOR UNIFORM LOAD OF 150 LBS. PER SQUARE FOOT

PROPER DISTANCE IN FEET CENTER TO CENTER OF BEAMS

Distance between Supports in Feet	24″ I	20″ I		18″ I	15″ I			12″ I		10
	80 lbs.	80 lbs.	65 lbs.	55 lbs.	80 lbs.	60 lbs.	42 lbs.	40 lbs.	31.5 lbs.	2 lb
12	85.9	72.4	57.7	43.7	52.4	40.1	29.1	22.1	17.7	12
13	73.2	61.7	49.2	37.2	44.7	34.2	24.8	18.9	15.1	10
14	63.1	53.2	42.5	32.1	38.5	29.5	21.4	16.3	13.1	8.
15	55.0	46.3	37.0	27.9	33.5	25.7	18.6	14.2	11.4	7.
16	48.3	40.7	32.5	24.5	29.5	22.5	16.3	12.5	10.0	6.
17	42.8	36.1	28.8	21.7	26.1	20.0	14.5	11.0	8.9	6.
18	38.2	32.2	25.7	19.4	23.3	17.8	12.9	9.9	7.9	5.
19	34.3	28.9	23.1	17.4	20.9	16.0	11.6	8.8	7.1	4.
20	30.9	26.1	20.8	15.7	18.9	14.5	10.5	8.0	6.4	4.
21	28.1	23.7	18.9	14.3	17.1	13.1	9.5	7.2	5.8	3.
22	25.6	21.5	17.2	13.0	15.6	11.9	8.7	6.6	5.3	3.
23	23.4	19.7	15.7	11.9	14.3	10.9	7.9	6.0	4.9	3.
24	21.5	18.1	14.5	10.9	13.1	10.0	7.3	5.5	4.5	3.
25	19.8	16.7	13.3	10.1	12.1	9.3	6.7	5.1	4.1	2.
26	18.3	15.4	12.3	9.3	11.1	8.5	6.2	4.7	3.8	2.
27	17.0	14.3	11.4	8.6	10.3	7.9	5.7	4.4	3.5	2.
28	15.8	13.3	10.6	8.0	9.6	7.3	5.3	4.1	3.3	2.
29	14.7	12.4	9.9	7.5	9.0	6.9	5.0	3.8	3.1	2.
30	13.7	11.6	9.3	7.0	8.4	6.4	4.7	3.5	2.9	1.

For load of 300 lbs. per square foot divide the spacing given b

Maximum fiber stress, 16,000 lbs. per square inch.

SPACING OF STANDARD I-BEAMS FOR UNIFORM LOAD OF 150 LBS. PER SQUARE FOOT

ROPER DISTANCE IN FEET CENTER TO CENTER OF BEAMS

9" I	8" I	7" I	6" I	5" I	4" I	3" I
21 lbs.	18 lbs.	15 lbs.	12.25 lbs.	9.75 lbs.	7.5 lbs.	5.5 lbs.
53.7	40.5	29.5	20.7	13.7	8.5	4.7
37.3	28.1	20.5	14.3	9.5	5.9	3.3
27.4	20.7	15.0	10.5	7.0	4.3	2.4
21.0	15.8	11.5	8.1	5.4	3.3	1.8
16.6	12.5	9.1	6.4	4.3	2.6	1.5
13.4	10.1	7.4	5.2	3.4	2.1	1.2
11.1	8.8	6.1	4.3	2.8	1.8	1.0
9.3	7.0	5.1	3.6	2.4	1.5	0.8
7.9	6.0	4.4	3.1	2.0	1.3	
6.9	5.2	3.8	2.6	1.8	1.1	
6.0	4.5	3.3	2.3	1.5	0.9	
5.2	4.0	2.9	2.0	1.4		
4.7	3.5	2.6	1.8	1.2		
4.1	3.1	2.3	1.6	1.1		
3.7	2.8	2.0	1.4	1.0		
3.4	2.5	1.8	1.3			
3.0	2.3	1.7	1.2			
2.8	2.1	1.5	1.1			

For load of 300 lbs. per square foot divide the spacing given by 2.
imum fiber stress, 16,000 lbs. per square inch.

SPACING OF STANDARD I-BEAMS FOR UNIFORM LOAD OF 175 LBS. PER SQUARE FOOT

PROPER DISTANCE IN FEET CENTER TO CENTER OF BEAM

Distance between Supports in Feet	24″ I	20″ I		18″ I	15″ I			12″ I		10″
	80 lbs.	80 lbs.	65 lbs.	55 lbs.	80 lbs.	60 lbs.	42 lbs.	40 lbs.	31.5 lbs.	25 lbs.
12	73.7	62.1	49.5	37.4	44.9	34.3	24.9	19.0	15.2	10.
13	62.7	52.9	42.2	31.9	38.3	29.3	21.3	16.2	13.0	8.
14	54.1	45.6	36.4	27.5	33.0	25.3	18.3	13.9	11.2	7.
15	47.1	39.7	31.7	23.9	28.7	22.0	15.9	12.2	9.8	6.
16	41.4	34.9	27.8	21.0	25.3	19.3	14.0	10.7	8.6	5.
17	36.7	30.9	24.7	18.6	22.4	17.1	12.4	9.4	7.6	5.
18	32.7	27.6	22.0	16.6	19.9	15.3	11.1	8.5	6.7	4.
19	29.4	24.7	19.8	14.9	17.9	13.7	9.9	7.5	6.1	4.
20	26.5	22.3	17.8	13.5	16.2	12.4	9.0	6.9	5.5	3.
21	24.1	20.3	16.2	12.2	14.7	11.2	8.1	6.2	5.0	3.
22	21.9	18.5	14.7	11.1	13.4	10.2	7.4	5.7	4.5	3.
23	20.1	16.9	13.5	10.2	12.2	9.4	6.8	5.1	4.2	2.
24	18.4	15.5	12.4	9.4	11.2	8.6	6.2	4.7	3.8	2.
25	17.0	14.3	11.4	8.6	10.3	7.9	5.8	4.4	3.5	2.
26	15.7	13.2	10.6	8.0	9.5	7.3	5.3	4.1	3.3	2.
27	14.6	12.3	9.8	7.4	8.9	6.8	4.9	3.8	3.0	2
28	13.5	11.4	9.1	6.9	8.2	6.3	4.6	3.5	2.8	1
29	12.6	10.6	8.5	6.4	7.7	5.9	4.3	3.3	2.6	1
30	11.8	9.9	7.9	6.0	7.2	5.5	4.0	3.0	2.5	1

For load of 350 lbs. per square foot divide the spacing given b
Maximum fiber stress, 16,000 lbs. per square inch.

SPACING OF STANDARD I-BEAMS FOR UNIFORM LOAD OF 175 LBS. PER SQUARE FOOT

OPER DISTANCE IN FEET CENTER TO CENTER OF BEAMS

9" I	8" I	7" I	6" I	5" I	4" I	3" I
21 lbs.	18 lbs.	15 lbs.	12.25 lbs.	9.75 lbs.	7.5 lbs.	5.5 lbs.
46.0	34.7	25.3	17.7	11.8	7.3	4.0
33.0	24.1	17.5	12.3	8.2	5.1	2.8
23.5	17.7	12.9	9.0	6.0	3.7	2.1
18.0	13.5	9.9	6.9	4.6	2.8	1.6
14.2	10.7	7.8	5.5	3.6	2.3	1.2
11.5	8.7	6.3	4.4	3.0	1.8	1.0
9.5	7.1	5.2	3.7	2.4	1.5	0.8
8.0	6.0	4.4	3.1	2.1	1.3	0.7
6.8	5.1	3.7	2.6	1.7	1.1	
5.9	4.4	3.2	2.3	1.5	0.9	
5.1	3.9	2.8	2.0	1.3	0.8	
4.5	3.4	2.5	1.7	1.2		
4.0	3.0	2.2	1.5	1.0		
3.6	2.7	2.0	1.4			
3.2	2.4	1.8	1.2			
2.9	2.2	1.6	1.1			
2.6	2.0	1.4	1.0			
2.4	1.8	1.3	0.9			

For load of *350 lbs.* per square foot divide the spacing given by 2.
ximum fiber stress, 16,000 lbs. per square inch.

EXPLANATION OF TABLES

ON THE PROPERTIES OF STANDARD AND SPECIAL I-B AND CHANNELS, STANDARD AND SPECIAL ANGLES, Z-BA TEES, TROUGH AND CORRUGATED PLATES AND STANDARD RAIL SECTIONS

(Pages 97 to 120 inclusive.)

The tables on I-beams, channels, Z-bars and angle calculated for all weights to which each pattern is rolled.

For tees, each shape can be rolled to one weight only

Columns 12 and 13 in the tables for I-beams and cha give coefficients by the help of which the safe, unifo distributed load may be readily and quickly determined. do this, it is only necessary to divide the coefficient give the span or distance between supports in feet.

If a section is to be selected (as will usually be the c intended to carry a certain load for a length of span alr determined on, it will only be necessary to ascertain coefficient which this load and span will require and ref the table for a section having a coefficient of this value. coefficient is obtained by multiplying the load in po uniformly distributed by the span length in feet.

In case the load is not uniformly distributed, but is centrated at the middle of the span, multiply the load by 2 then consider it as uniformly distributed. The deflection be $\frac{8}{10}$ of the deflection for the latter load.

For other cases of loading, obtain the bending mome foot-pounds (the most common cases are given on page this multiplied by 8 will give the coefficient required.

If the loads are quiescent, the coefficients for stress of 16,000 pounds per square inch for steel may be u but if moving loads are to be provided for, the coefficien 12,500 pounds should be taken. Inasmuch as the effec impact may be very considerable (the stresses produced i unyielding, inelastic material by a load suddenly ap being double those produced by the same load in a quie state), it will sometimes be advisable to use still smaller

ses than those given in the tables. In such cases the co-
ents can readily be determined by proportion. Thus, for
er stress of 8,000 lbs. per square inch the coefficient will
l the coefficient for 16,000 lbs. fiber stress divided by 2.

The section moduli are used to determine the fiber stress
square inch in a beam or other shape, subjected to bending
ransverse stresses, by simply dividing the same into the
ding moment expressed in inch-pounds.

The table on the properties of Carnegie T-shapes is
leled after the foregoing and will, therefore, scarcely
uire explanation. The horizontal portion of the T is called
flange and the vertical portion the stem. In the case of
neutral axis parallel to the flange, there will be two section
duli and the smaller is given. The fiber stress calculated
m it will, therefore, give the larger of the two stresses in
extreme fibers, since these stresses are equal to the bend-
moment divided by the section modulus of the section.

For Carnegie Z-bars complete tables of moments of inertia,
tion moduli, radii of gyration and values of the coefficients
) are given on pages 103 and 104 for thicknesses varying by
in. These coefficients may be applied, as explained above,
cases where the Z-bars are subjected to transverse loading
for example, in the case of roof-purlins. A table of safe
ads of Z-bars is given on page 75.

For angles there will be two section moduli for each posi-
on of the neutral axis, since the distance between the neutral
is and the extreme fibers has a different value on one side of
e axis from what it has on the other. The section modulus
iven in the table is the smaller of these two values.

Column 14 in the table of the "Properties of Beams" gives
e distance c. t. c. of beams, making the radii of gyration
qual for both axes.

The length of a beam used as a strut should not exceed
25 times its least radius of gyration.

Column 14 in the table of the "Properties of Standard
hannels" gives the distance which the channels should be
laced back to back to make the radii of gyration equal for
oth axes. *Column 15* in the same table can be used to obtain

the radius of gyration for struts consisting of two ch
when the distance back to back varies from that given
table.

These tables have all been prepared with great care
approximations have entered into any of the calculatic
that the figures given may be relied upon as accurate.

EXAMPLES

I. What section of I-beam will be required to carry
lbs. uniformly distributed, including its own weight,
span of 16 feet between supports, allowing a fiber str
16,000 lbs. per square inch?

Answer: The coefficient (C) required = 40,000 ×
640,000.

In table of Properties of I-Beams, page 98, look in c
12 for the nearest number corresponding to 640,000, wh
648,200. Therefore the beam to be used is 15 in. 45 lbs.

II. What load uniformly distributed will a 6 in.
carry, weighing 18.3 lbs. per foot and measuring
between supports, with a maximum fiber stress of 12,00

Answer: From table on page 104 the coefficient ((
a 6 in. Z-bar 18.3 lbs. = 78,600. Hence the safe load =
÷ 12, or 6,550 lbs., including weight of Z-bar.

III. A light 4 × 3 in. angle weighing 7.1 lbs. per
spanning 4 ft., is loaded with 1,000 lbs. at center. Wh
be the maximum fiber stress, if the 4 in. flange is in a v
position?

Answer: Bending moment = 12,000 inch-pounds.

From table, section modulus = 1.23. Therefore, max

fiber stress $= \frac{12,000}{1.23}$ or 9,756 lbs., which is the stress fu
from the neutral axis, *i. e.*, at the end of the long flange

SPECIAL CASES OF LOADING

Beam loaded by a single load P at a point distant "b" rom the left hand and "a" feet from the right hand ›rt.

= length of beam between supports = a + b.

ressure or reaction at left hand support = $P\frac{a}{l}$ and at hand support = $P\frac{b}{l}$.

Maximum bending moment neglecting dead weight of ι occurs at point of application of the load and = $\frac{Pab}{l}$.

? = load given in tables, pages 70 to 80 × $\frac{l^2}{8ab}$.

When a = b = ½ l:

Reaction = $\frac{P}{2}$; *maximum bending moment* = $\frac{Pl}{4}$ and P ad given in tables × ½.

[I. Beam fixed at one end and unsupported at the other, resenting the length of beam from end to support.

[f loaded by a uniformly distributed load W:

Maximum bending moment occurs at support and = $\frac{Wl}{2}$.

W = load given in tables, pages 70 to 80 × ¼.

[f loaded with a single load P at its extremity:

Maximum bending moment occurs at support and = Pl.

P = load given in tables × ⅛.

GENERAL FORMULÆ ON THE FLEXURE OF BE
ANY CROSS-SECTION

Let A = area of section in square inches,
l = length of span in inches,
W = load uniformly distributed in pounds,
M = bending moment in inch-pounds,
h = height of cross-section, out to out, in inches,
n = distance of center of gravity of section, fro from bottom, in inches,
f = stress per square inch in extreme fibers c either top or bottom, in pounds, accordin lates to distance from top or from bottom o
D = maximum deflection in inches,
I = moment of inertia of section neutral axis center of gravity,
I'' = moment of inertia of section neutral axis pa above, but not through center of gravity,
d = distance between these neutral axes,
S = section modulus,
r = radius of gyration in inches,
E = modulus of elasticity for steel 29,000,000;

Then: $S = \frac{I}{n}$, $\qquad r = \sqrt{\frac{I}{A}}$,

$$M = \frac{f\,I}{n} = f\,S,$$

$$f = \frac{Mn}{I} = \frac{M}{S},$$

$$W = \frac{8\,f\,I}{ln} = \frac{8\,f}{l}S,$$

$$f = \frac{Wln}{8I} = \frac{Wl}{8\,S},$$

$$I'' = I + Ad^2,$$

$D = \frac{5\,Wl^3}{384\,EI}$ for beam supported at both ends formly loaded,

$D = \frac{Pl^3}{48\,EI}$ for beam supported at both ends ar with a single load P at middle,

$D = \frac{Wl^3}{8\,EI}$ for beam fixed at one end and uns at the other and uniformly loaded

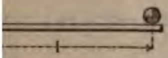
$D = \frac{Pl^3}{3\,EI}$ for beam fixed at one end and uns at other and loaded with a single the latter end.

MOMENTS AND DEFLECTIONS OF BEAMS UNDER VARIOUS SYSTEMS OF LOADING

:total load
ength of beam

I=moment of Inertia
E=modulus of elasticity

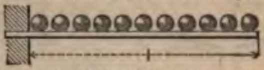
at one end and loaded at the



; that given in tables.
bending moment at
ipport=Wl.
hear at point of sup-

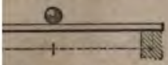
$\frac{Wl^3}{3EI}$.

(2.) Beam fixed at one end and uniformly loaded.



Safe load=¼ that given in tables.
Maximum bending moment at point of support=$\frac{Wl}{2}$.
Maximum shear at point of support=W.
Deflection=$\frac{Wl^3}{8\,EI}$.

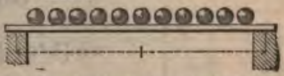
ted at both ends, single load in
e.



{ that given in tables.
ending moment at mid-
ı=$\frac{Wl}{4}$.
hear at points of sup-

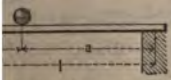
=$\frac{Wl^3}{48EI}$.

(4.) Beam supported at both ends and uniformly loaded.



Safe load=that given in tables.
Maximum bending moment at middle of beam=$\frac{Wl}{8}$.
Maximum shear at points of support=½W.
Deflection=$\frac{Wl^3}{76.8\,EI}$.

rted at both ends, single unsym-
load.



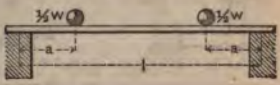
that given in tables

ending moment under

hears: at support near
other support =$\frac{Wa}{l}$.

=$\frac{Wab(2l-a)}{9EIl}\sqrt{\frac{1}{3}a(2l-a.)}$

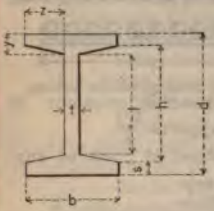
(6.) Beam supported at both ends, two symmetrical loads.



Safe load = that given in tables $\times\frac{1}{4a}$.
Maximum bending moment between loads=½Wa.
Maximum shear between load and nearer support=½W.
Max. Deflection=$\frac{Wa}{48EI}(3l^2-4a^2)$.

VALUES OF MOMENTS OF INERTIA FO[R] CARNEGIE STANDARD SHAPES

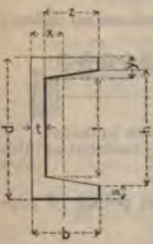
I = Moment of Inertia Neutral Axis Parallel to Flange
I′ = " " " " " " " Web



$$\text{Area}=A=dt+(s+y)2z.$$

$$I=\tfrac{1}{12}[bd^3-\tfrac{3}{2}(h^4-l^4)].$$

$$I'=\tfrac{1}{12}[b^3(d-h)+lt^3+\tfrac{1}{24}(b^4-t^4)$$

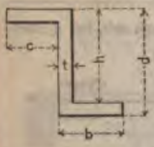


$$\text{Area}=A=dt+(s+y)z.$$

$$x=[b^2s+\tfrac{1}{2}ht^2+\tfrac{1}{18}(b-t)^2(b+2t)]\div A.$$

$$I=\tfrac{1}{12}[bd^3-\tfrac{3}{4}(h^4-l^4)].$$

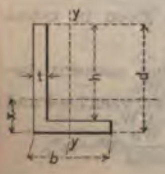
$$I'=\tfrac{1}{3}[2sb^3+lt^3+\tfrac{1}{12}(b^4-t^4)]-Ax^2.$$



$$\text{Area}=A=(d+2c)t.$$

$$I=\tfrac{1}{12}[bd^3-c(2h-d)^3].$$

$$I'=\tfrac{1}{12}[d(b+c)^3-2hc(c^2+3b^2)].$$

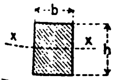
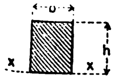
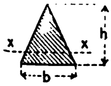
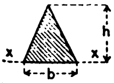
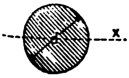
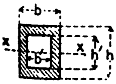
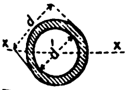
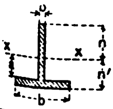
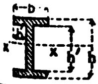


$$\text{Area}=A=(b+d-t)t.$$

$$x=\frac{t(2h+b)+h^2}{2(h+b)}.$$

$$I=\tfrac{1}{3}[bx^3+t(d-x)^3-(b-t)(x-t)^3].$$

VALUES OF I (Moment of Inertia) AND S (Section Modulus) FOR USUAL SECTIONS

Sections	I	S
	$I=\frac{bh^3}{12}$.	$\frac{bh^2}{6}$.
	$I'=\frac{bh^3}{3}$.	
	$I=\frac{bh^3}{36}$.	$\text{Min.}=\frac{bh^2}{24}$.
	$I'=\frac{bh^3}{12}$.	
	$I=\frac{\pi d^4}{64}$ $=0.0491\ d^4$.	$\frac{\pi d^3}{32}$ $=0.0982\ d^3$.
	$I=\frac{bh^3-b'h'^3}{12}$.	$\frac{I}{0.5h}$.
	$I=0.0491(d^4-d'^4)$.	$0.0982\left(d^3-\frac{d'^4}{d}\right)$.
	$I=\frac{b'n^3+bn'^3-(b-b')a^3}{3}$.	$\text{Min.}=\frac{I}{n}$.
	$I=\frac{bh^3-2b'h'^3}{12}$.	$\frac{I}{0.5h}$.

xx Denotes position of neutral axis.

PROPERTIES OF

	2	3	4	5	6	7	8	9
Section Index	Depth of Beam Inches	Weight per Foot Pounds	Area of Section Square Inches	Thickness of Web Inches	Width of Flange Inches	Mom. of Inertia Neutral Axis Perpendicular to Web at Center I	Mom. of Inertia Neutral Axis Coincident with Center Line of Web I′	Radius of Gyration Neutral Axis Perpendicular to Web at Center r
1	24	100.00	29.41	0.754	7.254	2380.3	48.56	9.00
		95.00	27.94	0.692	7.192	2309.6	47.10	9.09
		90.00	26.47	0.631	7.131	2239.1	45.70	9.20
		85.00	25.00	0.570	7.070	2168.6	44.35	9.31
		80.00	**23.32**	**0.500**	**7.000**	**2087.9**	**42.86**	**9.46**
2	20	100.00	29.41	0.884	7.284	1655.8	52.65	7.50
		95.00	27.94	0.810	7.210	1606.8	50.78	7.58
		90.00	26.47	0.737	7.137	1557.8	48.98	7.67
		85.00	25.00	0.663	7.063	1508.7	47.25	7.77
		80.00	**23.73**	**0.600**	**7.000**	**1466.5**	**45.81**	**7.86**
3	20	75.00	22.06	0.649	6.399	1268.9	30.25	7.58
		70.00	20.59	0.575	6.325	1219.9	29.04	7.70
		65.00	**19.08**	**0.500**	**6.250**	**1169.6**	**27.86**	**7.83**
80	18	70.00	20.59	0.719	6.259	921.3	24.62	6.69
		65.00	19.12	0.637	6.177	881.5	23.47	6.79
		60.00	17.65	0.555	6.095	841.8	22.38	6.91
		55.00	**15.93**	**0.460**	**6.000**	**795.6**	**21.19**	**7.07**
4	15	100.00	29.41	1.184	6.774	900.5	50.98	5.53
		95.00	27.94	1.085	6.675	872.9	48.37	5.59
		90.00	26.47	0.987	6.577	845.4	45.91	5.65
		85.00	25.00	0.889	6.479	817.8	43.57	5.72
		80.00	**23.81**	**0.810**	**6.400**	**795.5**	**41.76**	**5.78**
5	15	75.00	22.06	0.882	6.292	691.2	30.68	5.60
		70.00	20.59	0.784	6.194	663.6	29.00	5.68
		65.00	19.12	0.686	6.096	636.0	27.42	5.77
		60.00	**17.67**	**0.590**	**6.000**	**609.0**	**25.96**	**5.87**
7	15	55.00	16.18	0.656	5.746	511.0	17.06	5.62
		50.00	14.71	0.558	5.648	483.4	16.04	5.73
		45.00	13.24	0.460	5.550	455.8	15.00	5.87
		42.00	**12.48**	**0.410**	**5.500**	**441.7**	**14.62**	**5.95**
8	12	55.00	16.18	0.822	5.612	321.0	17.46	4.45
		50.00	14.71	0.699	5.489	303.3	16.12	4.54
		45.00	13.24	0.576	5.366	285.7	14.89	4.65
		40.00	**11.84**	**0.460**	**5.250**	**268.9**	**13.81**	**4.77**
9	12	35.00	10.29	0.436	5.086	228.3	10.07	4.71
		31.50	**9.26**	**0.350**	**5.000**	**215.8**	**9.50**	**4.83**
11	10	40.00	11.76	0.749	5.099	158.7	9.50	3.67
		35.00	10.29	0.602	4.952	146.4	8.52	3.77
		30.00	8.82	0.455	4.805	134.2	7.65	3.90
		25.00	**7.37**	**0.310**	**4.660**	**122.1**	**6.89**	**4.07**
13	9	35.00	10.29	0.732	4.772	111.8	7.31	3.29
		30.00	8.82	0.569	4.609	101.9	6.42	3.40
		25.00	7.35	0.406	4.446	91.9	5.65	3.54
		21.00	**6.31**	**0.290**	**4.330**	**84.9**	**5.16**	**3.67**

L=Safe load in pounds uniformly distributed; l=Span in feet.
M′=Moment of forces in foot pounds; C and C′=Coefficients given on opposite page.

Weights in heavy print are standard, others are special.

I-BEAMS

11 Section Modulus Neutral Axis Perpendicular to Web at Center	12 Coefficient of Strength for Fiber Stress of 16,000 lbs. per sq. in. Used for Buildings C	13 Coefficient of Strength for Fiber Stress of 12,500 lbs. per sq. in. Used for Bridges C′	14 Distance Center to Center Required to make Radii of Gyration equal D	
198.4	2115800	1653000	17.82	B
192.5	2052900	1603900	17.99	
186.6	1990300	1554900	18.21	
180.7	1927600	1505900	18.43	
174.0	1855900	1449900	18.72	
165.6	1766100	1379800	14.76	B
160.7	1713000	1339000	14.93	
155.8	1661600	1298100	15.10	
150.9	1609800	1257200	15.30	
146.7	1564300	1222100	15.47	
126.9	1353500	1057400	14.98	B 3
122.0	1301200	1016600	15.21	
117.0	1247600	974700	15.47	
102.4	1091900	853000	13.20	B 80
97.9	1044800	816200	13.40	
93.5	997700	779500	13.63	
88.4	943000	736700	13.95	
120.1	1280700	1000600	10.75	B 4
116.4	1241500	969900	10.86	
112.7	1202300	939300	10.99	
109.0	1163000	908600	11.13	
106.1	1131300	883900	11.25	
92.2	983000	768000	10.95	B 5
88.5	943800	737400	11.11	
84.8	904600	706700	11.29	
81.2	866100	676600	11.49	
68.1	726800	567800	11.05	B 7
64.5	687500	537100	11.27	
60.8	648200	506400	11.54	
58.9	628300	490800	11.70	
53.5	570600	445800	8.65	B 8
50.6	539200	421300	8.83	
47.6	507900	396800	9.06	
44.8	478100	373500	9.29	
38.0	405800	317000	9.21	B 9
36.0	383700	299700	9.45	
31.7	338500	264500	7.12	B 11
29.3	312400	244100	7.32	
26.8	286300	223600	7.57	
24.4	260500	203500	7.91	
24.8	265000	207000	6.86	B 13
22.6	241500	188700	7.58	
20.4	217900	170300	6.86	
18.9	201300	157300	7.12	

...or C′ / l ; $M' = \frac{C \text{ or } C'}{8}$; C or C′ = L l = 8 M′ = $\frac{8 f S}{...}$

PROPERTIES OF

1	2	3	4	5	6	7	8	
Section Index	Depth of Beam Inches	Weight per Foot Pounds	Area of Section Square Inches	Thickness of Web Inches	Width of Flange Inches	Mom. of Inertia Neutral Axis Perpendicular to Web at Center I	Mom. of Inertia Neutral Axis Coincident with Center Line of Web I'	Radius of Gyration Neu-
B 15	8	25.50 23.00 20.50 **18.00**	7.50 6.76 6.03 **5.33**	0.541 0.449 0.357 **0.270**	4.271 4.179 4.087 **4.000**	68.4 64.5 60.6 **56.9**	4.75 4.39 4.07 **3.78**	**3**
B 17	7	20.00 17.50 **15.00**	5.88 5.15 **4.42**	0.458 0.353 **0.250**	3.868 3.763 **3.660**	42.2 39.2 **36.2**	3.24 2.94 **2.67**	**2**
B 19	6	17.25 14.75 **12.25**	5.07 4.34 **3.61**	0.475 0.352 **0.230**	3.575 3.452 **3.330**	26.2 24.0 **21.8**	2.36 2.09 **1.85**	**2**
B 21	5	14.75 12.25 **9.75**	4.34 3.60 **2.87**	0.504 0.357 **0.210**	3.294 3.147 **3.000**	15.2 13.6 **12.1**	1.70 1.45 **1.23**	**2**
B 23	4	10.50 9.50 8.50 **7.50**	3.09 2.79 2.50 **2.21**	0.410 0.337 0.263 **0.190**	2.880 2.807 2.733 **2.660**	7.1 6.7 6.4 **6.0**	1.01 0.93 0.85 **0.77**	**1**
B 77	3	7.50 6.50 **5.50**	2.21 1.91 **1.63**	0.361 0.263 **0.170**	2.521 2.423 **2.330**	2.9 2.7 **2.5**	0.60 0.53 **0.46**	**1**

Weights in heavy print are standard, others are special.

PROPERTIES OF CARNEGIE TROUGH PLATES

Section Index	Size Inches	Thickness Inches	Weight per Foot Pounds	Area of Section Square Inches	Moment of Inertia Neutral Axis Parallel to Length I	Section Modulus Axis as Before S
M 10	9½x3¼	½	16.3	4.8	3.68	1.38
M 11	9½x3¾	$\frac{9}{16}$	18.0	5.3	4.13	1.57
M 12	9½x3¼	⅝	19.7	5.8	4.57	1.77
M 13	9½x3¾	$\frac{11}{16}$	21.4	6.3	5.02	1.96
M 14	*9½x3¼*	¾	23.2	6.8	5.46	2.15

I-BEAMS—Continued

	11	12	13	14	15
… Line of Web	Section Modulus Neutral Axis Perpendicular to Web at Center S	Coefficient of Strength for Fiber Stress of 16,000 lbs. per sq. in. Used for Buildings C	Coefficient of Strength for Fiber Stress of 12,500 lbs. per sq. in. Used for Bridges C′	Distance Center to Center Required to make Radii of Gyration equal D	Section Index
0	17.1	182500	142600	5.82	B 15
1	16.1	172000	134400	5.96	
2	15.1	161600	126200	6.12	
4	14.2	151700	118500	6.32	
4	12.1	128600	100400	5.15	B 17
6	11.2	119400	93300	5.31	
3	10.4	110400	86300	5.50	
8	8.7	93100	72800	4.33	B 19
9	8.0	85300	66600	4.49	
2	7.3	77500	60500	4.70	
3	6.1	64600	50500	......	B 21
3	5.4	58100	45400	......	
5	4.8	51600	40300	......	
7	3.6	38100	29800	......	B 23
3	3.4	36000	28100	......	
3	3.2	33900	26500	......	
9	3.0	31800	24900	......	
2	1.9	20700	16200	......	B 77
3	1.8	19100	15000	......	
3	1.7	17600	13800	......	

ROPERTIES OF CARNEGIE CORRUGATED PLATES

Size Inches	Thickness Inches	Weight per Foot Pounds	Area of Section Square Inch	Moment of Inertia Neutral Axis Parallel to Length I	Section Modulus Axis as before S	Radius of Gyration Axis as before r
$8\frac{3}{4}\times1\frac{1}{2}$	$\frac{1}{4}$	8.1	2.4	0.64	0.80	0.52
$8\frac{3}{4}\times1\frac{9}{16}$	$\frac{5}{16}$	10.1	3.0	0.95	1.13	0.57
$8\frac{3}{4}\times1\frac{5}{8}$	$\frac{3}{8}$	12.0	3.5	1.25	1.42	0.62
$12\frac{3}{16}\times2\frac{3}{4}$	$\frac{3}{8}$	17.75	5.2	4.79	3.33	0.96
$12\frac{3}{16}\times2\frac{13}{16}$	$\frac{7}{16}$	20.71	6.1	5.81	3.90	0.98
$12\frac{3}{16}\times2\frac{7}{8}$	$\frac{1}{2}$	23.67	7.0	6.82	4.46	0.99

PROPERTIES OF

1	2	3	4	5	6	7	8	9
Section Index	Depth of Channel Inches	Weight per Foot Pounds	Area of Section Square Inches	Thickness of Web Inches	Width of Flange Inches	Mom. of Inertia Neutral Axis Perpendicular to Web at Center I	Mom. of Inertia Neutral Axis Parallel with Center Line of Web I′	Radius of Gyration Neutral Axis Perpendicular to Web at Cent… r
C 1	15	55.00	16.18	0.818	3.818	430.2	12.19	5.16
		50.00	14.71	0.720	3.720	402.7	11.22	5.23
		45.00	13.24	0.622	3.622	375.1	10.29	5.32
		40.00	11.76	0.524	3.524	347.5	9.39	5.43
		35.00	10.29	0.426	3.426	320.0	8.48	5.58
		33.00	**9.90**	**0.400**	**3.400**	**312.6**	**8.23**	**5.62**
C 2	12	40.00	11.76	0.758	3.418	197.0	6.63	4.09
		35.00	10.29	0.636	3.296	179.3	5.90	4.17
		30.00	8.82	0.513	3.173	161.7	5.21	4.28
		25.00	7.35	0.390	3.050	144.0	4.53	4.43
		20.50	**6.03**	**0.280**	**2.940**	**128.1**	**3.91**	**4.61**
C 3	10	35.00	10.29	0.823	3.183	115.5	4.66	3.35
		30.00	8.82	0.676	3.036	103.2	3.90	3.42
		25.00	7.35	0.529	2.889	91.0	3.40	3.52
		20.00	5.88	0.382	2.742	78.7	2.85	3.66
		15.00	**4.46**	**0.240**	**2.600**	**66.9**	**2.30**	**3.87**
C 4	9	25.00	7.35	0.615	2.815	70.7	2.98	3.10
		20.00	5.88	0.452	2.652	60.8	2.45	3.21
		15.00	4.41	0.288	2.488	50.9	1.95	3.40
		13.25	**3.89**	**0.230**	**2.430**	**47.3**	**1.77**	**3.49**
C 5	8	21.25	6.25	0.582	2.622	47.8	2.25	2.77
		18.75	5.51	0.490	2.530	43.8	2.01	2.82
		16.25	4.78	0.399	2.439	39.9	1.78	2.89
		13.75	4.04	0.307	2.347	36.0	1.55	2.98
		11.25	**3.35**	**0.220**	**2.260**	**32.3**	**1.33**	**3.11**
C 6	7	19.75	5.81	0.633	2.513	33.2	1.85	2.39
		17.25	5.07	0.528	2.408	30.2	1.62	2.44
		14.75	4.34	0.423	2.303	27.2	1.40	2.50
		12.25	3.60	0.318	2.198	24.2	1.19	2.59
		9.75	**2.85**	**0.210**	**2.090**	**21.1**	**0.98**	**2.72**
C 7	6	15.50	4.56	0.563	2.283	19.5	1.28	2.07
		13.00	3.82	0.440	2.160	17.3	1.07	2.13
		10.50	3.09	0.318	2.038	15.1	0.88	2.21
		8.00	**2.38**	**0.200**	**1.920**	**13.0**	**0.70**	**2.34**
C 8	5	11.50	3.38	0.477	2.037	10.4	0.82	1.75
		9.00	2.65	0.330	1.890	8.9	0.64	1.83
		6.50	**1.95**	**0.190**	**1.750**	**7.4**	**0.48**	**1.95**
C 9	4	7.25	2.13	0.325	1.725	4.6	0.44	1.46
		6.25	1.84	0.252	1.652	4.2	0.38	1.51
		5.25	**1.55**	**0.180**	**1.580**	**3.8**	**0.32**	**1.56**
C 72	3	6.00	1.76	0.362	1.602	2.1	0.31	1.08
		5.00	1.47	0.264	1.504	1.8	0.25	1.12
		4.00	**1.19**	**0.170**	**1.410**	**1.6**	**0.20**	**1.17**

L = Safe load in pounds uniformly distributed; l = Span in feet.
M′ = Moment of forces in foot pounds; C and C′ = Coefficients given on opposite page.
Weights in heavy print are standard, others are special.

CHANNELS

11	12	13	14	15	16
Section Modulus Neutral Axis Perpendicular to Web at Center S	Coefficient of Strength for Fiber Stress of 16,000 lbs. per sq. in. Used for Buildings C	Coefficient of Strength for Fiber Stress of 12,500 lbs. per sq. in. Used for Bridges C′	Distance Required to make Radii of Gyration Equal D	Distance of Center of Gravity from Outside of Web x	Section Index
57.4	611900	478000	8.53	0.823	
53.7	572700	447400	8.71	0.803	
50.0	533500	416800	8.92	0.788	
46.3	494200	386100	9.15	0.783	C 1
42.7	455000	355500	9.43	0.789	
41.7	**444500**	**347300**	**9.50**	**0.794**	
32.8	350200	273600	6.60	0.722	
29.9	318800	249100	6.81	0.694	
26.9	287400	224500	7.07	0.677	C 2
24.0	256100	200000	7.36	0.678	
21.4	**227800**	**178000**	**7.67**	**0.704**	
23.1	246400	192500	5.17	0.695	
20.6	220300	172100	5.40	0.651	
18.2	194100	151700	5.67	0.620	C 3
15.7	168000	131200	5.97	0.609	
13.4	**142700**	**111500**	**6.33**	**0.639**	
15.7	167600	130900	4.84	0.615	
13.5	144100	112600	5.12	0.585	C 4
11.3	120500	94200	5.49	0.590	
10.5	**112200**	**87600**	**5.63**	**0.607**	
11.9	127400	99500	4.23	0.587	
11.0	116900	91300	4.38	0.567	
10.0	106400	83200	4.54	0.556	C 5
9.0	96000	75000	4.72	0.557	
8.1	**86100**	**67300**	**4.94**	**0.576**	
9.5	101100	79000	3.48	0.583	
8.6	92000	71800	3.64	0.555	
7.8	82800	64700	3.80	0.535	C 6
6.9	73700	57500	3.99	0.528	
6.0	**66800**	**52200**	**4.22**	**0.546**	
6.5	69500	54300	2.91	0.546	
5.8	61600	48100	3.09	0.517	C 7
5.0	53800	42000	3.28	0.503	
4.3	**46200**	**36100**	**3.52**	**0.517**	
4.2	44400	34700	2.34	0.508	
3.5	37900	29600	2.56	0.481	C 8
3.0	**31600**	**24700**	**2.79**	**0.489**	
2.3	24400	19000	1.85	0.463	
2.1	22300	17400	1.96	0.458	C 9
1.9	**20200**	**15800**	**2.06**	**0.464**	
1.4	14700	11500	1.07	0.459	
1.2	13100	10800	1.19	0.443	C 72
1.1	**11600**	**9100**	**1.31**	**0.443**	

$\frac{C \text{ or } C'}{l}$; $M' = \frac{C \text{ or } C'}{8}$ $C \text{ or } C' = Ll = 8M' = \frac{8fS}{12}$.

PROPERTIES OF

1	2	3	4	5	6	7	8
						Moments of Inertia I	
Section Index	Depth of Web Inches	Width of Flange Inches	Thickness of Metal Inches	Weight per Foot Pounds	Area of Section Square Inches	Neutral Axis Through Center of Gravity Perpendicular to Web	Neutral Axis Through Center of Gravity Coincident with Web
Z 1	6	$3\frac{1}{2}$	$\frac{3}{8}$	15.6	4.59	25.32	9.11
	$6\frac{1}{16}$	$3\frac{9}{16}$	$\frac{7}{16}$	18.3	5.39	29.80	10.95
	$6\frac{1}{8}$	$3\frac{5}{8}$	$\frac{1}{2}$	21.0	6.19	34.36	12.87
Z 2	6	$3\frac{1}{2}$	$\frac{9}{16}$	22.7	6.68	34.64	12.59
	$6\frac{1}{16}$	$3\frac{9}{16}$	$\frac{5}{8}$	25.4	7.46	38.86	14.42
	$6\frac{1}{8}$	$3\frac{5}{8}$	$\frac{11}{16}$	28.0	8.25	43.18	16.34
Z 3	6	$3\frac{1}{2}$	$\frac{3}{4}$	29.3	8.63	42.12	15.44
	$6\frac{1}{16}$	$3\frac{9}{16}$	$\frac{13}{16}$	31.9	9.40	46.13	17.27
	$6\frac{1}{8}$	$3\frac{5}{8}$	$\frac{7}{8}$	34.6	10.17	50.22	19.18
Z 4	5	$3\frac{1}{4}$	$\frac{5}{16}$	11.6	3.40	13.36	6.18
	$5\frac{1}{16}$	$3\frac{5}{16}$	$\frac{3}{8}$	13.9	4.10	16.18	7.65
	$5\frac{1}{8}$	$3\frac{3}{8}$	$\frac{7}{16}$	16.4	4.81	19.07	9.20
Z 5	5	$3\frac{1}{4}$	$\frac{1}{2}$	17.9	5.25	19.19	9.05
	$5\frac{1}{16}$	$3\frac{5}{16}$	$\frac{9}{16}$	20.2	5.94	21.83	10.51
	$5\frac{1}{8}$	$3\frac{3}{8}$	$\frac{5}{8}$	22.6	6.64	24.53	12.06
Z 6	5	$3\frac{1}{4}$	$\frac{11}{16}$	23.7	6.96	23.68	11.37
	$5\frac{1}{16}$	$3\frac{5}{16}$	$\frac{3}{4}$	26.0	7.64	26.16	12.83
	$5\frac{1}{8}$	$3\frac{3}{8}$	$\frac{13}{16}$	28.3	8.33	28.70	14.36
Z 7	4	$3\frac{1}{16}$	$\frac{1}{4}$	8.2	2.41	6.28	4.23
	$4\frac{1}{16}$	$3\frac{1}{8}$	$\frac{5}{16}$	10.3	3.03	7.94	5.46
	$4\frac{1}{8}$	$3\frac{3}{16}$	$\frac{3}{8}$	12.4	3.66	9.63	6.77
Z 8	4	$3\frac{1}{16}$	$\frac{7}{16}$	13.8	4.05	9.66	6.73
	$4\frac{1}{16}$	$3\frac{1}{8}$	$\frac{1}{2}$	15.8	4.66	11.18	7.96
	$4\frac{1}{8}$	$3\frac{3}{16}$	$\frac{9}{16}$	17.9	5.27	12.74	9.26
Z 9	4	$3\frac{1}{16}$	$\frac{5}{8}$	18.9	5.55	12.11	8.73
	$4\frac{1}{16}$	$3\frac{1}{8}$	$\frac{11}{16}$	20.9	6.14	13.52	9.95
	$4\frac{1}{8}$	$3\frac{3}{16}$	$\frac{3}{4}$	23.0	6.75	14.97	11.24
Z 10	3	$2\frac{11}{16}$	$\frac{1}{4}$	6.7	1.97	2.87	2.81
	$3\frac{1}{16}$	$2\frac{3}{4}$	$\frac{5}{16}$	8.4	2.48	3.64	3.64
Z 11	3	$2\frac{11}{16}$	$\frac{3}{8}$	9.7	2.86	3.85	3.92
	$3\frac{1}{16}$	$2\frac{3}{4}$	$\frac{7}{16}$	11.4	3.36	4.57	4.75
Z 12	3	$2\frac{11}{16}$	$\frac{1}{2}$	12.5	3.69	4.59	4.85
	$3\frac{1}{16}$	$2\frac{3}{4}$	$\frac{9}{16}$	14.2	4.18	5.28	5.70

STANDARD Z-BARS

	10	11	12	13	14	15	16
tion	Moduli S	Radii of Gyration r			Coefficient of Strength		Section Index
					C	C′	
…rpendicular to Web	Neutral Axis through Center of Gravity Coincident with Web	Neutral Axis through Center of Gravity Perpendicular to Web	Neutral Axis through Center of Gravity Coincident with Web	Least Radius, Neutral Axis Diagonal	For Fiber Stress of 16,000 lbs. per sq. in., Axis Perpendicular to Web at Center	For Fiber Stress of 12,000 lbs. per sq. in., Axis Perpendicular to Web at Center	
4	2.75	2.35	1.41	0.83	90000	67500	
3	3.27	2.35	1.43	0.84	104800	78600	Z 1
2	3.81	2.36	1.44	0.84	119700	89800	
2	3.91	2.28	1.37	0.81	123200	92400	
2	4.43	2.28	1.39	0.82	136700	102600	Z 2
0	4.98	2.29	1.41	0.84	150400	112800	
4	4.94	2.21	1.34	0.81	149800	112300	
2	5.47	2.22	1.36	0.82	162300	121800	Z 3
0	6.02	2.22	1.37	0.83	174900	131200	
4	2.00	1.98	1.35	0.75	57000	42700	
9	2.45	1.99	1.37	0.76	68200	51100	Z 4
4	2.92	1.99	1.38	0.77	79400	59500	
8	3.02	1.91	1.31	0.74	81900	61400	
2	3.47	1.91	1.33	0.75	91900	69000	Z 5
7	3.94	1.92	1.35	0.76	102100	76600	
7	3.91	1.84	1.28	0.73	101000	75800	
4	4.37	1.85	1.30	0.75	110300	82700	Z 6
0	4.84	1.86	1.31	0.76	119500	89600	
4	1.44	1.62	1.33	0.67	33500	25100	
1	1.84	1.62	1.34	0.68	41700	31300	Z 7
7	2.26	1.62	1.36	0.69	49800	37400	
3	2.37	1.55	1.29	0.66	51500	38600	
0	2.77	1.55	1.31	0.67	58700	44000	Z 8
8	3.19	1.55	1.33	0.69	65900	49400	
5	3.18	1.48	1.25	0.66	64500	48400	
5	3.58	1.48	1.27	0.67	70900	53200	Z 9
6	4.00	1.49	1.29	0.69	77400	58100	
2	1.10	1.21	1.19	0.55	20500	15400	Z 10
8	1.40	1.21	1.21	0.56	25400	19000	
7	1.57	1.16	1.17	0.55	27400	20600	Z 11
8	1.88	1.17	1.19	0.56	31800	23800	
6	1.99	*1.12*	1.15	0.55	32600	24500	Z 12
3	*2.31*	*1.12*	1.17	0.56	36600	27400	

PROPERTIES OF

1	2	3	4	5	6
Section Index	Size, Flange by Stem Inches	Weight per Foot Pounds	Area of Section Square Inches	Distance of Center of Gravity from Outside of Flange, Inches	Moment of Inertia, Neutral Axis through Center of Gravity Parallel to Flange I
T50	5 x3	13.6	3.99	0.75	2.6
T51	5 x2½	11.0	3.24	0.65	1.6
T52	4½x3½	15.9	4.65	1.11	5.1
T53	4½x3	8.6	2.55	0.73	1.8
T54	4½x3	10.0	3.00	0.75	2.1
T55	4½x2½	8.0	2.40	0.58	1.1
T56	4½x2½	9.3	2.79	0.60	1.2
T57	4 x5	15.7	4.56	1.56	10.7
T58	4 x5	12.3	3.54	1.51	8.5
T59	4 x4½	14.8	4.29	1.37	8.0
T60	4 x4½	11.6	3.36	1.31	6.3
T 1	4 x4	13.9	4.02	1.18	5.7
T 2	4 x4	10.9	3.21	1.15	4.7
T61	4 x3	9.3	2.73	0.78	2.0
T62	4 x2½	8.7	2.52	0.63	1.2
T63	4 x2½	7.4	2.16	0.60	1.0
T64	4 x2	7.9	2.31	0.48	0.6
T65	4 x2	6.7	1.95	0.51	0.54
T66	3½x4	12.8	3.75	1.25	5.5
T67	3½x4	10.0	2.91	1.19	4.3
T 3	3½x3½	11.9	3.45	1.06	3.7
T 4	3½x3½	9.3	2.70	1.01	3.0
T69	3½x3	11.0	3.21	0.88	2.4
T70	3½x3	8.7	2.49	0.83	1.9
T71	3½x3	7.7	2.28	0.78	1.6
T72	3 x4	11.9	3.48	1.32	5.2
T73	3 x4	10.6	3.12	1.32	4.8
T74	3 x4	9.3	2.73	1.29	4.3
T75	3 x3½	11.0	3.21	1.12	3.5

CARNEGIE T SHAPES

9	10	11	12	13
Moment of Inertia, Neutral Axis through Center of Gravity Coincident with Center Line of Stem	Section Modulus, Neutral Axis as before	Radius of Gyration, Neutral Axis as before	Coefficient of Strength for Fiber Stress of 16,000 lbs. per square inch, Neutral Axis through Center of Gravity Parallel to Flange	Coefficient of Strength for Fiber Stress of 12,000 lbs. per square inch, Neutral Axis as before
I′	S′	r′	C	C′
5.6	2.22	1.19	12550	9410
4.3	1.70	1.16	9200	6900
3.7	1.65	0.90	22690	17020
2.6 3.1	1.16 1.38	1.03 1.04	8650 10050	6490 7540
2.6 3.1	1.16 1.38	1.07 1.08	6030 6950	4520 5220
2.8 2.1	1.41 1.06	0.79 0.78	33070 25880	24800 19410
2.8 2.1	1.41 1.06	0.81 0.80	27200 21120	20400 15840
2.8 2.2	1.40 1.09	0.84 0.84	21550 17470	16170 13100
2.1	1.05	0.88	9430	7070
2.1 1.8	1.05 0.88	0.92 0.91	6640 5850	4980 4380
2.1 1.8	1.05 0.88	0.96 0.95	4250 3600	3180 2700
1.89 1.42	1.08 0.81	0.72 0.70	21150 16510	15870 12380
1.89 1.42	1.08 0.81	0.74 0.73	16210 12710	12160 9530
1.88 1.41 1.18	1.08 0.81 0.68	0.77 0.75 0.76	12070 9390 7720	9050 7040 5790
1.21 1.09 0.93	0.81 0.72 0.62	0.59 0.60 0.59	20650 19030 16720	15480 14270 12540
1.20	*0.80*	0.62	15880	11910

PROPERTIES OF

1	2	3	4	5	6
Section Index	Size, Flange by Stem Inches	Weight per Foot Pounds	Area of Section, Square Inches	Distance of Center of Gravity from Outside of Flange, Inches	Moment of Inertia, Neutral Axis through Center of Gravity Parallel to Flange I
T76	3 x 3½	9.8	2.88	1.11	3.3
T77	3 x 3½	8.6	2.49	1.09	2.9
T 6	3 x 3	10.1	2.94	0.93	2.3
T 7	3 x 3	9.0	2.67	0.92	2.1
T 8	3 x 3	7.9	2.28	0.88	1.8
T 9	3 x 3	6.8	1.95	0.86	1.6
T78	3 x 2½	7.2	2.10	0.71	1.1
T79	3 x 2½	6.2	1.80	0.68	0.94
T80	2¾ x 2	7.4	2.16	0.53	1.1
T82	2½ x 3	7.2	2.10	0.97	1.8
T83	2½ x 3	6.2	1.80	0.92	1.6
T84	2½ x 2¾	6.8	1.98	0.87	1.4
T85	2½ x 2¾	5.9	1.71	0.83	1.2
T10	2½ x 2½	6.5	1.89	0.76	1.0
T11	2½ x 2½	5.6	1.62	0.74	0.87
T86	2½ x 1¼	3.0	0.84	0.29	0.094
T12	2¼ x 2¼	5.0	1.44	0.69	0.66
T13	2¼ x 2¼	4.2	1.20	0.66	0.51
T14	2 x 2	4.4	1.26	0.63	0.45
T15	2 x 2	3.7	1.08	0.59	0.36
T87	2 x 1½	3.2	0.90	0.42	0.16
T16	1¾ x 1¾	3.2	0.90	0.54	0.23
T17	1½ x 1½	2.6	0.75	0.42	0.15
T18	1½ x 1½	2.0	0.54	0.44	0.11
T19	1¼ x 1¼	2.1	0.60	0.40	0.08
T20	1¼ x 1¼	1.7	0.45	0.38	0.06
T21	1 x 1	1.3	0.36	0.32	0.03
T22	1 x 1	1.0	0.26	0.29	0.02

CARNEGIE T SHAPES—Continued

9	10	11	12	13
Moment of Inertia, Neutral Axis through Center of Gravity Coincident with Center Line of Stem	Section Modulus, Neutral Axis as before	Radius of Gyration, Neutral Axis as before	Coefficient of Strength for Fiber Stress of 16,000 lbs. per square inch, Neutral Axis through Center of Gravity Parallel to Flange	Coefficient of Strength for Fiber Stress of 12,000 lbs. per square inch, Neutral Axis as before
I'	S'	r'	C	C'
1.31	0.88	0.68	14650	10990
0.93	0.62	0.61	12910	9680
1.20	0.80	0.64	11710	8780
1.08	0.72	0.64	10810	8110
0.90	0.60	0.63	9200	6900
0.75	0.50	0.62	7870	5900
0.89	0.60	0.66	6400	4800
0.75	0.50	0.65	5470	4100
0.62	0.45	0.54	8000	6000
0.54	0.43	0.51	9280	6960
0.44	0.35	0.51	8150	6110
0.66	0.53	0.58	7810	5860
0.44	0.35	0.51	6440	4830
0.52	0.42	0.53	6270	4700
0.44	0.35	0.52	5330	4000
0.29	0.23	0.58	950	710
0.33	0.30	0.48	4480	3360
0.25	0.22	0.47	3450	2600
0.23	0.23	0.43	3480	2610
0.18	0.18	0.42	2670	2000
0.18	0.18	0.45	1600	1200
0.12	0.14	0.37	2050	1540
0.08	0.10	0.34	1530	1150
0.06	0.07	0.31	1150	860
0.05	0.07	0.27	1010	760
0.03	0.05	0.26	750	560
0.02	0.04	0.21	490	370
0.01	0.02	0.21	320	240

PROPERTIES OF

ANGLES WITH UNEQUAL LEGS

1	2	3	4	5	6	7
Section Index	Size Inches	Thickness Inches	Weight per Foot Pounds	Area of Section Square Inches	Perpendicular Distances from Center of Gravity to Back of Flanges	
					To Back of Longer Flange	To Back of Shorter Flange
*A140	8 x3½	$\frac{11}{20}$	20.5	6.02	0.75	3.00
*A150	7 x3½	1	32.3	9.50	0.96	2.71
*A151	7 x3½	$\frac{15}{16}$	30.5	8.97	0.94	2.69
*A152	7 x3½	⅞	28.7	8.42	0.92	2.67
*A153	7 x3½	$\frac{13}{16}$	26.8	7.87	0.89	2.64
*A154	7 x3½	¾	24.9	7.31	0.87	2.62
*A155	7 x3½	$\frac{11}{16}$	23.0	6.75	0.85	2.60
*A156	7 x3½	⅝	21.0	6.17	0.82	2.57
*A157	7 x3½	$\frac{9}{16}$	19.1	5.59	0.80	2.55
*A158	7 x3½	½	17.0	5.00	0.78	2.53
*A159	7 x3½	$\frac{7}{16}$	15.0	4.40	0.75	2.50
A 89	6 x4	1	30.6	9.00	1.17	2.17
A 91	6 x4	$\frac{15}{16}$	28.9	8.50	1.14	2.14
A160	6 x4	⅞	27.2	7.99	1.12	2.12
A161	6 x4	$\frac{13}{16}$	25.4	7.47	1.10	2.10
A162	6 x4	¾	23.6	6.94	1.08	2.08
A163	6 x4	$\frac{11}{16}$	21.8	6.41	1.06	2.06
A164	6 x4	⅝	20.0	5.86	1.03	2.03
A165	6 x4	$\frac{9}{16}$	18.1	5.31	1.01	2.01
A166	6 x4	½	16.2	4.75	0.99	1.99
A167	6 x4	$\frac{7}{16}$	14.3	4.18	0.96	1.96
A168	6 x4	⅜	12.3	3.61	0.94	1.94
A 92	6 x3½	1	28.9	8.50	1.01	2.26
A 93	6 x3½	$\frac{15}{16}$	27.3	8.03	0.99	2.24
A169	6 x3½	⅞	25.7	7.55	0.97	2.22
A170	6 x3½	$\frac{13}{16}$	24.0	7.06	0.95	2.20
A171	6 x3½	¾	22.4	6.56	0.93	2.18
A172	6 x3½	$\frac{11}{16}$	20.6	6.06	0.90	2.15
A173	6 x3½	⅝	18.9	5.55	0.88	2.13
A174	6 x3½	$\frac{9}{16}$	17.1	5.03	0.86	2.11
A175	6 x3½	½	15.3	4.50	0.83	2.08
A176	6 x3½	$\frac{7}{16}$	13.5	3.97	0.81	2.06
A177	6 x3½	⅜	11.7	3.42	0.79	2.04
*A178	5 x4	⅞	24.2	7.11	1.21	1.71
*A179	5 x4	$\frac{13}{16}$	22.7	6.65	1.18	1.68
*A180	5 x4	¾	21.1	6.19	1.16	1.66

Angles marked * are special

STANDARD AND SPECIAL ANGLES

ANGLES WITH UNEQUAL LEGS

9	10	11	12	13	14	15
…nts of Inertia I	Section Moduli S		Radii of Gyration r			Section Index
Neutral Axis Parallel to Shorter Flange	Neutral Axis Parallel to Longer Flange	Neutral Axis Parallel to Shorter Flange	Neutral Axis Parallel to Longer Flange	Neutral Axis Parallel to Shorter Flange	Least Radius	
39.96	1.79	7.99	0.90	2.58	0.74	A 140*
45.37	2.96	10.58	0.89	2.19	0.88	A 150*
3.13	2.80	10.00	0.89	2.19	0.88	A 151*
.82	2.64	9.42	0.90	2.20	0.88	A 152*
45	2.48	8.82	0.91	2.21	0.88	A 153*
99	2.31	8.22	0.91	2.22	0.88	A 154*
7	2.14	7.60	0.92	2.23	0.89	A 155*
[illegible]	1.97	6.97	0.93	2.24	0.89	A 156*
[illegible]	1.80	6.33	0.93	2.25	0.89	A 157*
[illegible]	1.62	5.68	0.94	2.25	0.89	A 158*
[illegible]	1.47	5.01	0.95	2.26	0.89	A 159*
[illegible]	3.79	8.02	1.09	1.85	0.85	A 89
[illegible]	3.59	7.59	1.10	1.86	0.85	A 91
[illegible]	3.39	7.15	1.11	1.86	0.86	A 160
[illegible]	3.18	6.70	1.11	1.87	0.86	A 161
[illegible]	2.97	6.25	1.12	1.88	0.86	A 162
[illegible]	2.76	5.78	1.13	1.89	0.86	A 163
[illegible]	2.54	5.31	1.13	1.90	0.86	A 164
[illegible]	2.31	4.83	1.14	1.90	0.87	A 165
[illegible]	2.08	4.33	1.15	1.91	0.87	A 166
[illegible]	1.85	3.83	1.16	1.92	0.87	A 167
[illegible]	1.60	3.32	1.17	1.93	0.88	A 168
[illegible]	2.90	7.83	0.92	1.85	0.74	A 92
[illegible]	2.74	7.41	0.93	1.86	0.74	A 93
[illegible]	2.59	6.98	0.93	1.87	0.75	A 169
[illegible]	2.43	6.55	0.94	1.88	0.75	A 170
4	2.27	6.10	0.94	1.89	0.75	A 171
4	2.11	5.65	0.95	1.89	0.75	A 172
08	1.94	5.19	0.96	1.90	0.75	A 173
.37	1.77	4.72	0.96	1.91	0.75	A 174
.59	1.59	4.24	0.97	1.92	0.76	A 175
4.76	1.41	3.75	0.98	1.93	0.76	A 176
2.86	1.23	3.25	0.99	1.94	0.77	A 177
16.42	3.31	4.99	1.14	1.52	0.84	A 178*
15.54	3.11	4.69	1.15	1.53	0.84	A 179*
14.60	2.90	4.37	1.15	1.54	0.84	A 180*

Angles marked * are special

PROPERTIES OF

ANGLES WITH UNEQUAL LEGS

1	2	3	4	5	6	
Section Index	Size Inches	Thickness Inches	Weight per Foot Pounds	Area of Section Square Inches	Perpendicular Dis[tance] from Center of G[rav]ity to Back o[f] Flanges	
					To Back of Longer Flange	To Back of Sh[orter Flange]
*A181	5 x4	$\frac{11}{16}$	19.5	5.72	1.14	1.
*A182	5 x4	$\frac{5}{8}$	17.8	5.23	1.12	1.
*A183	5 x4	$\frac{9}{16}$	16.2	4.75	1.10	1.
*A184	5 x4	$\frac{1}{2}$	14.5	4.25	1.07	1.
*A185	5 x4	$\frac{7}{16}$	12.8	3.75	1.05	1.
*A186	5 x4	$\frac{3}{8}$	11.0	3.23	1.03	1.
A187	5 x3½	$\frac{7}{8}$	22.7	6.67	1.04	1.
A188	5 x3½	$\frac{13}{16}$	21.3	6.25	1.02	1.
A189	5 x3½	$\frac{3}{4}$	19.8	5.81	1.00	1.
A190	5 x3½	$\frac{11}{16}$	18.3	5.37	0.97	1.
A191	5 x3½	$\frac{5}{8}$	16.8	4.92	0.95	1.
A192	5 x3½	$\frac{9}{16}$	15.2	4.47	0.93	1.
A193	5 x3½	$\frac{1}{2}$	13.6	4.00	0.91	1.
A194	5 x3½	$\frac{7}{16}$	12.0	3.53	0.88	1.
A195	5 x3½	$\frac{3}{8}$	10.4	3.05	0.86	1.
A 96	5 x3½	$\frac{5}{16}$	8.7	2.56	0.84	1.
A196	5 x3	$\frac{13}{16}$	19.9	5.84	0.86	1.
A197	5 x3	$\frac{3}{4}$	18.5	5.44	0.84	1.
A198	5 x3	$\frac{11}{16}$	17.1	5.03	0.82	1.
A199	5 x3	$\frac{5}{8}$	15.7	4.61	0.80	1.
A200	5 x3	$\frac{9}{16}$	14.3	4.18	0.77	1.
A201	5 x3	$\frac{1}{2}$	12.8	3.75	0.75	1.
A202	5 x3	$\frac{7}{16}$	11.3	3.31	0.73	1.
A203	5 x3	$\frac{3}{8}$	9.8	2.86	0.70	1.
A280	5 x3	$\frac{5}{16}$	8.2	2.40	0.68	1.
*A204	4½x3	$\frac{13}{16}$	18.5	5.43	0.90	1.
*A205	4½x3	$\frac{3}{4}$	17.3	5.06	0.88	1.
*A206	4½x3	$\frac{11}{16}$	16.0	4.68	0.85	1.
*A207	4½x3	$\frac{5}{8}$	14.7	4.30	0.83	1.
*A208	4½x3	$\frac{9}{16}$	13.3	3.90	0.81	1.
*A209	4½x3	$\frac{1}{2}$	11.9	3.50	0.79	1.
*A210	4½x3	$\frac{7}{16}$	10.6	3.09	0.76	1.
*A211	4½x3	$\frac{3}{8}$	9.1	2.67	0.74	1.
*A 97	4½x3	$\frac{5}{16}$	7.7	2.25	0.72	1.

Angles marked * are special

AND SPECIAL ANGLES—Continued

ANGLES WITH UNEQUAL LEGS

10	11	12	13	14	15
Section Moduli S		Radii of Gyration r			Section Index
Neutral Axis Parallel to Longer Flange	Neutral Axis Parallel to Shorter Flange	Neutral Axis Parallel to Longer Flange	Neutral Axis Parallel to Shorter Flange	Least Radius	
2.69	4.05	1.16	1.54	0.84	A181*
2.48	3.73	1.17	1.55	0.84	A182*
2.26	3.39	1.18	1.56	0.85	A183*
2.04	3.05	1.18	1.57	0.85	A184*
1.81	2.70	1.19	1.58	0.85	A185*
1.57	2.34	1.20	1.59	0.86	A186*
2.52	4.88	0.96	1.53	0.75	A187
2.37	4.58	0.97	1.54	0.75	A188
2.22	4.28	0.98	1.55	0.75	A189
2.06	3.97	0.98	1.56	0.75	A190
1.90	3.65	0.99	1.56	0.75	A191
1.73	3.32	1.00	1.57	0.75	A192
1.56	2.99	1.01	1.58	0.75	A193
1.39	2.64	1.01	1.59	0.76	A194
1.21	2.29	1.02	1.60	0.76	A195
1.02	1.94	1.03	1.61	0.76	A 96
1.74	4.45	0.80	1.55	0.64	A196
1.63	4.16	0.80	1.55	0.64	A197
1.51	3.86	0.81	1.56	0.64	A198
1.39	3.55	0.82	1.57	0.64	A199
1.27	3.23	0.82	1.58	0.65	A200
1.15	2.91	0.83	1.59	0.65	A201
1.02	2.58	0.84	1.60	0.65	A202
0.89	2.24	0.84	1.61	0.65	A203
0.75	1.89	0.85	1.61	0.66	A280
1.71	3.62	0.81	1.38	0.64	A204*
1.60	3.38	0.82	1.39	0.64	A205*
1.49	3.14	0.83	1.39	0.64	A206*
1.37	2.89	0.83	1.40	0.64	A207*
1.25	2.64	0.85	1.41	0.64	A208*
1.13	2.37	0.85	1.42	0.65	A209*
1.01	2.10	0.85	1.43	0.65	A210*
0.88	1.83	0.86	1.44	0.66	A211*
0.76	1.54	0.88	1.44	0.66	A 97

Angles marked * are special

PROPERTIES OF

ANGLES WITH UNEQUAL LEGS

1	2	3	4	5	6	7
Section Index	Size Inches	Thickness Inches	Weight per Foot Pounds	Area of Section Square Inches	Perpendicular Distances from Center of Gravity to Back of Flanges	
					To Back of Longer Flange	To Back of Shorter Flange
*A212	4 x3½	13/16	18.5	5.43	1.11	1.36
*A213	4 x3½	¾	17.3	5.06	1.09	1.34
*A214	4 x3½	11/16	16.0	4.68	1.07	1.32
*A215	4 x3½	⅝	14.7	4.30	1.04	1.29
*A216	4 x3½	9/16	13.3	3.90	1.02	1.27
*A217	4 x3½	½	11.9	3.50	1.00	1.25
*A218	4 x3½	7/16	10.6	3.09	0.98	1.23
*A219	4 x3½	⅜	9.1	2.67	0.96	1.21
*A 98	4 x3½	5/16	7.7	2.25	0.93	1.18
A220	4 x3	13/16	17.1	5.03	0.94	1.44
A221	4 x3	¾	16.0	4.69	0.92	1.42
A222	4 x3	11/16	14.8	4.34	0.89	1.39
A223	4 x3	⅝	13.6	3.98	0.87	1.37
A224	4 x3	9/16	12.4	3.62	0.85	1.35
A225	4 x3	½	11.1	3.25	0.83	1.33
A226	4 x3	7/16	9.8	2.87	0.80	1.30
A227	4 x3	⅜	8.5	2.48	0.78	1.28
A228	4 x3	5/16	7.2	2.09	0.76	1.26
A229	3½x3	13/16	15.8	4.62	0.98	1.23
A230	3½x3	¾	14.7	4.31	0.96	1.21
A231	3½x3	11/16	13.6	4.00	0.94	1.19
A232	3½x3	⅝	12.5	3.67	0.92	1.17
A233	3½x3	9/16	11.4	3.34	0.90	1.15
A234	3½x3	½	10.2	3.00	0.88	1.13
A235	3½x3	7/16	9.1	2.65	0.85	1.10
A236	3½x3	⅜	7.9	2.30	0.83	1.08
A237	3½x3	5/16	6.6	1.93	0.81	1.06
A238	3½x2½	11/16	12.5	3.65	0.77	1.27
A239	3½x2½	⅝	11.5	3.36	0.75	1.25
A240	3½x2½	9/16	10.4	3.06	0.73	1.23
A241	3½x2½	½	9.4	2.75	0.70	1.20
A242	3½x2½	7/16	8.3	2.43	0.68	1.18
A243	3½x2½	⅜	7.2	2.11	0.66	1.16
A244	3½x2½	5/16	6.1	1.78	0.64	1.14
A245	3½x2½	¼	4.9	1.44	0.61	1.11

Angles marked * are special

STANDARD AND SPECIAL ANGLES—Continued

ANGLES WITH UNEQUAL LEGS

8	9	10	11	12	13	14	15
…ments of Inertia I		Section Moduli S		Radii of Gyration r			Section Index
…Longer Flange	Neutral Axis Parallel to Shorter Flange	Neutral Axis Parallel to Longer Flange	Neutral Axis Parallel to Shorter Flange	Neutral Axis Parallel to Longer Flange	Neutral Axis Parallel to Shorter Flange	Least Radius	
	7.77	2.30	2.92	1.01	1.19	0.72	A21
	7.32	2.15	2.75	1.01	1.20	0.72	A21
	6.86	2.00	2.56	1.02	1.21	0.72	A21
	6.37	1.84	2.35	1.03	1.22	0.72	A21
	5.86	1.68	2.15	1.03	1.23	0.72	A21
	5.32	1.52	1.93	1.04	1.23	0.72	A21
	4.76	1.35	1.72	1.05	1.24	0.72	A21
	4.18	1.18	1.50	1.06	1.25	0.73	A21
	3.56	1.01	1.26	1.07	1.26	0.73	A 9
	7.34	1.68	2.87	0.83	1.21	0.64	A22
	6.93	1.57	2.68	0.84	1.22	0.64	A22
	6.49	1.46	2.49	0.84	1.22	0.64	A22
	6.03	1.35	2.30	0.85	1.23	0.64	A22
	5.55	1.23	2.09	0.86	1.24	0.64	A22
	5.05	1.12	1.89	0.86	1.25	0.64	A22
	4.52	0.99	1.68	0.87	1.25	0.64	A22
	3.96	0.87	1.46	0.88	1.26	0.64	A22
	3.38	0.74	1.23	0.89	1.27	0.65	A22
	4.98	1.65	2.20	0.85	1.04	0.62	A22
	4.70	1.54	2.05	0.85	1.04	0.62	A23
	4.41	1.44	1.91	0.86	1.05	0.62	A23
	4.11	1.33	1.76	0.87	1.06	0.62	A23
	3.79	1.21	1.61	0.87	1.07	0.62	A23
	3.45	1.10	1.45	0.88	1.07	0.62	A23
	3.10	0.98	1.29	0.89	1.08	0.62	A23
	2.72	0.85	1.13	0.90	1.09	0.62	A23
	2.33	0.72	0.96	0.90	1.10	0.63	A23
	4.13	0.99	1.85	0.67	1.06	0.53	A23
	3.85	0.92	1.71	0.69	1.07	0.53	A23
	3.55	0.84	1.56	0.70	1.08	0.53	A24
	3.24	0.76	1.41	0.70	1.09	0.53	A24
	2.91	0.68	1.26	0.71	1.09	0.54	A24
	2.56	0.59	1.09	0.72	1.10	0.54	A24
	2.19	0.50	0.93	0.73	1.11	0.54	A24
	1.80	0.41	0.75	0.74	1.12	0.54	A24

Angles marked * are special

PROPERTIES OF

ANGLES WITH UNEQUAL LEGS

1	2	3	4	5	6	7
Section Index	Size Inches	Thickness Inches	Weight per Foot Pounds	Area of Section Square Inches	Perpendicular Distances from Center of Gravity to Back of Flanges	
					To Back of Longer Flange	To Back of Shorter Flange
*A181	5 x4	11/16	19.5	5.72	1.14	1.64
*A182	5 x4	5/8	17.8	5.23	1.12	1.62
*A183	5 x4	9/16	16.2	4.75	1.10	1.60
*A184	5 x4	1/2	14.5	4.25	1.07	1.57
*A185	5 x4	7/16	12.8	3.75	1.05	1.55
*A186	5 x4	3/8	11.0	3.23	1.03	1.53
A187	5 x3½	7/8	22.7	6.67	1.04	1.79
A188	5 x3½	13/16	21.3	6.25	1.02	1.77
A189	5 x3½	3/4	19.8	5.81	1.00	1.75
A190	5 x3½	11/16	18.3	5.37	0.97	1.72
A191	5 x3½	5/8	16.8	4.92	0.95	1.70
A192	5 x3½	9/16	15.2	4.47	0.93	1.68
A193	5 x3½	1/2	13.6	4.00	0.91	1.66
A194	5 x3½	7/16	12.0	3.53	0.88	1.63
A195	5 x3½	3/8	10.4	3.05	0.86	1.61
A 96	5 x3½	5/16	8.7	2.56	0.84	1.59
A196	5 x3	13/16	19.9	5.84	0.86	1.86
A197	5 x3	3/4	18.5	5.44	0.84	1.84
A198	5 x3	11/16	17.1	5.03	0.82	1.82
A199	5 x3	5/8	15.7	4.61	0.80	1.80
A200	5 x3	9/16	14.3	4.18	0.77	1.77
A201	5 x3	1/2	12.8	3.75	0.75	1.75
A202	5 x3	7/16	11.3	3.31	0.73	1.73
A203	5 x3	3/8	9.8	2.86	0.70	1.70
A280	5 x3	5/16	8.2	2.40	0.68	1.68
*A204	4½x3	13/16	18.5	5.43	0.90	1.65
*A205	4½x3	3/4	17.3	5.06	0.88	1.63
*A206	4½x3	11/16	16.0	4.68	0.85	1.60
*A207	4½x3	5/8	14.7	4.30	0.83	1.58
*A208	4½x3	9/16	13.3	3.90	0.81	1.56
*A209	4½x3	1/2	11.9	3.50	0.79	1.54
*A210	4½x3	7/16	10.6	3.09	0.76	1.51
*A211	4½x3	3/8	9.1	2.67	0.74	1.49
*A 97	4½x3	5/16	7.7	2.25	0.72	1.47

Angles marked * are special

STANDARD AND SPECIAL ANGLES—Continu

ANGLES WITH UNEQUAL LEGS

8	9	10	11	12	13	14	
oments of Inertia I		Section Moduli S		Radii of Gyration r			
Parallel to Longer Flange	Neutral Axis Parallel to Shorter Flange	Neutral Axis Parallel to Longer Flange	Neutral Axis Parallel to Shorter Flange	Neutral Axis Parallel to Longer Flange	Neutral Axis Parallel to Shorter Flange	Least Radius	
70	13.62	2.69	4.05	1.16	1.54	0.84	A
14	12.61	2.48	3.73	1.17	1.55	0.84	A
56	11.55	2.26	3.39	1.18	1.56	0.85	A
96	10.46	2.04	3.05	1.18	1.57	0.85	A
2	9.32	1.81	2.70	1.19	1.58	0.85	A
7	8.14	1.57	2.34	1.20	1.59	0.86	A
1	15.67	2.52	4.88	0.96	1.53	0.75	A
9	14.81	2.37	4.58	0.97	1.54	0.75	A
5	13.92	2.22	4.28	0.98	1.55	0.75	A
0	12.99	2.06	3.97	0.98	1.56	0.75	A
3	12.03	1.90	3.65	0.99	1.56	0.75	A
5	11.03	1.73	3.32	1.00	1.57	0.75	A
5	9.99	1.56	2.99	1.01	1.58	0.75	A
3	8.90	1.39	2.64	1.01	1.59	0.76	A
8	7.78	1.21	2.29	1.02	1.60	0.76	A
2	6.60	1.02	1.94	1.03	1.61	0.76	A
71	13.98	1.74	4.45	0.80	1.55	0.64	A
51	13.15	1.63	4.16	0.80	1.55	0.64	A
29	12.28	1.51	3.86	0.81	1.56	0.64	A
06	11.37	1.39	3.55	0.82	1.57	0.64	A
83	10.43	1.27	3.23	0.82	1.58	0.65	A
58	9.45	1.15	2.91	0.83	1.59	0.65	A
32	8.43	1.02	2.58	0.84	1.60	0.65	A
04	7.37	0.89	2.24	0.84	1.61	0.65	A
.75	6.26	0.75	1.89	0.85	1.61	0.66	A
.60	10.33	1.71	3.62	0.81	1.38	0.64	A
.40	9.73	1.60	3.38	0.82	1.39	0.64	A
.19	9.10	1.49	3.14	0.83	1.39	0.64	A
.98	8.44	1.37	2.89	0.83	1.40	0.64	A
.75	7.75	1.25	2.64	0.85	1.41	0.64	A
.51	7.04	1.13	2.37	0.85	1.42	0.65	A
25	6.29	1.01	2.10	0.85	1.43	0.65	A
.98	5.50	0.88	1.83	0.86	1.44	0.66	A
.73	4.69	0.76	1.54	0.88	1.44	0.68	[illegible]

Angles marked * are special

PROPERTIES OF

ANGLES WITH UNEQUAL LEGS

1	2	3	4	5	6	7
Section Index	Size Inches	Thickness Inches	Weight per Foot Pounds	Area of Section Square Inches	Perpendicular Distances from Center of Gravity to Back of Flanges	
					To Back of Longer Flange	To Back of Shorter Flange
*A212	4 x3½	13/16	18.5	5.43	1.11	1.36
*A213	4 x3½	¾	17.3	5.06	1.09	1.34
*A214	4 x3½	11/16	16.0	4.68	1.07	1.32
*A215	4 x3½	⅝	14.7	4.30	1.04	1.29
*A216	4 x3½	9/16	13.3	3.90	1.02	1.27
*A217	4 x3½	½	11.9	3.50	1.00	1.25
*A218	4 x3½	7/16	10.6	3.09	0.98	1.23
*A219	4 x3½	⅜	9.1	2.67	0.96	1.21
*A 98	4 x3½	5/16	7.7	2.25	0.93	1.18
A220	4 x3	13/16	17.1	5.03	0.94	1.44
A221	4 x3	¾	16.0	4.69	0.92	1.42
A222	4 x3	11/16	14.8	4.34	0.89	1.39
A223	4 x3	⅝	13.6	3.98	0.87	1.37
A224	4 x3	9/16	12.4	3.62	0.85	1.35
A225	4 x3	½	11.1	3.25	0.83	1.33
A226	4 x3	7/16	9.8	2.87	0.80	1.30
A227	4 x3	⅜	8.5	2.48	0.78	1.28
A228	4 x3	5/16	7.2	2.09	0.76	1.26
A229	3½x3	13/16	15.8	4.62	0.98	1.23
A230	3½x3	¾	14.7	4.31	0.96	1.21
A231	3½x3	11/16	13.6	4.00	0.94	1.19
A232	3½x3	⅝	12.5	3.67	0.92	1.17
A233	3½x3	9/16	11.4	3.34	0.90	1.15
A234	3½x3	½	10.2	3.00	0.88	1.13
A235	3½x3	7/16	9.1	2.65	0.85	1.10
A236	3½x3	⅜	7.9	2.30	0.83	1.08
A237	3½x3	5/16	6.6	1.93	0.81	1.06
A238	3½x2½	11/16	12.5	3.65	0.77	1.27
A239	3½x2½	⅝	11.5	3.36	0.75	1.25
A240	3½x2½	9/16	10.4	3.06	0.73	1.23
A241	3½x2½	½	9.4	2.75	0.70	1.20
A242	3½x2½	7/16	8.3	2.43	0.68	1.18
A243	3½x2½	⅜	7.2	2.11	0.66	1.16
A244	3½x2½	5/16	6.1	1.78	0.64	1.14
A245	3½x2½	¼	4.9	1.44	0.61	1.11

Angles marked * are special

STANDARD AND SPECIAL ANGLES—Continued

ANGLES WITH UNEQUAL LEGS

8	9	10	11	12	13	14	15
...ents of Inertia I		Section Moduli S		Radii of Gyration r			Section Index
...r Flange	Neutral Axis Parallel to Shorter Flange	Neutral Axis Parallel to Longer Flange	Neutral Axis Parallel to Shorter Flange	Neutral Axis Parallel to Longer Flange	Neutral Axis Parallel to Shorter Flange	Least Radius	
	7.77	2.30	2.92	1.01	1.19	0.72	A21
	7.32	2.15	2.75	1.01	1.20	0.72	A21
	6.86	2.00	2.56	1.02	1.21	0.72	A21
	6.37	1.84	2.35	1.03	1.22	0.72	A21
	5.86	1.68	2.15	1.03	1.23	0.72	A21
	5.32	1.52	1.93	1.04	1.23	0.72	A21
	4.76	1.35	1.72	1.05	1.24	0.72	A21
	4.18	1.18	1.50	1.06	1.25	0.73	A21
	3.56	1.01	1.26	1.07	1.26	0.73	A 9
	7.34	1.68	2.87	0.83	1.21	0.64	A22
	6.93	1.57	2.68	0.84	1.22	0.64	A22
	6.49	1.46	2.49	0.84	1.22	0.64	A22
	6.03	1.35	2.30	0.85	1.23	0.64	A22
	5.55	1.23	2.09	0.86	1.24	0.64	A22
	5.05	1.12	1.89	0.86	1.25	0.64	A22
	4.52	0.99	1.68	0.87	1.25	0.64	A22
	3.96	0.87	1.46	0.88	1.26	0.64	A22
	3.38	0.74	1.23	0.89	1.27	0.65	A22
	4.98	1.65	2.20	0.85	1.04	0.62	A22
	4.70	1.54	2.05	0.85	1.04	0.62	A23
	4.41	1.44	1.91	0.86	1.05	0.62	A23
	4.11	1.33	1.76	0.87	1.06	0.62	A23
	3.79	1.21	1.61	0.87	1.07	0.62	A23
	3.45	1.10	1.45	0.88	1.07	0.62	A23
	3.10	0.98	1.29	0.89	1.08	0.62	A23
	2.72	0.85	1.13	0.90	1.09	0.62	A23
	2.33	0.72	0.96	0.90	1.10	0.63	A23
...2	4.13	0.99	1.85	0.67	1.06	0.53	A23
...51	3.85	0.92	1.71	0.69	1.07	0.53	A23
...49	3.55	0.84	1.56	0.70	1.08	0.53	A24
1.36	3.24	0.76	1.41	0.70	1.09	0.53	A24
1.23	2.91	0.68	1.26	0.71	1.09	0.54	A24
1.09	2.56	0.59	1.09	0.72	1.10	0.54	A24
0.94	2.19	0.50	0.93	0.73	1.11	0.54	A24
0.78	1.80	0.41	0.75	0.74	1.12	0.54	A24

Angles marked * are special

PROPERTIES OF

ANGLES WITH UNEQUAL LEGS

1	2	3	4	5	6
Section Index	Size Inches	Thickness Inches	Weight per Foot Pounds	Area of Section Square Inches	Perpendicular from Center ity to Ba Flang To Back of Longer Flange
*A246	3¼x2	9/16	9.0	2.64	0.59
*A247	3¼x2	½	8.1	2.38	0.57
*A248	3¼x2	7/16	7.2	2.11	0.54
*A249	3¼x2	⅜	6.3	1.83	0.52
*A250	3¼x2	5/16	5.3	1.54	0.50
*A251	3¼x2	¼	4.3	1.25	0.48
A252	3 x2½	9/16	9.5	2.78	0.77
A253	3 x2½	½	8.5	2.50	0.75
A254	3 x2½	7/16	7.6	2.22	0.73
A255	3 x2½	⅜	6.6	1.92	0.71
A256	3 x2½	5/16	5.6	1.62	0.68
A257	3 x2½	¼	4.5	1.31	0.66
*A258	3 x2	½	7.7	2.25	0.58
*A259	3 x2	7/16	6.8	2.00	0.56
*A260	3 x2	⅜	5.9	1.73	0.54
*A261	3 x2	5/16	5.0	1.47	0.52
*A262	3 x2	¼	4.1	1.19	0.49
A264	2½x2	½	6.8	2.00	0.63
A265	2½x2	7/16	6.1	1.78	0.60
A266	2½x2	⅜	5.3	1.55	0.58
A267	2½x2	5/16	4.5	1.31	0.56
A268	2½x2	¼	3.7	1.06	0.54
A269	2½x2	3/16	2.8	0.81	0.51
*A270	2¼x1½	½	5.6	1.63	0.48
*A271	2¼x1½	7/16	5.0	1.45	0.46
*A272	2¼x1½	⅜	4.4	1.27	0.44
*A273	2¼x1½	5/16	3.7	1.07	0.42
*A274	2¼x1½	¼	3.0	0.88	0.39
*A275	2¼x1½	3/16	2.3	0.67	0.37
*A276	2 x1⅜	¼	2.7	0 78	0.37
*A277	2 x1⅜	3/16	2.1	0.60	0.35
*A278	1⅜x1	¼	1.9	0.53	0.29
*A279	1⅜x1	⅛	1.0	0.28	0.26

Angles marked * are special

TANDARD AND SPECIAL ANGLES—Continued

ANGLES WITH UNEQUAL LEGS

8	9	10	11	12	13	14	15
…ments of Inertia I		Section Moduli S		Radii of Gyration r			Section Index
… Longer Flange	Neutral Axis Parallel to Shorter Flange	Neutral Axis Parallel to Longer Flange	Neutral Axis Parallel to Shorter Flange	Neutral Axis Parallel to Longer Flange	Neutral Axis Parallel to Shorter Flange	Least Radius	
75	2.64	0.53	1.30	0.53	1.00	0.44	A246*
69	2.42	0.48	1.17	0.54	1.01	0.44	A247*
62	2.18	0.43	1.05	0.54	1.02	0.44	A248*
55	1.92	0.37	0.91	0.55	1.02	0.44	A249*
48	1.65	0.32	0.77	0.56	1.03	0.45	A250*
40	1.36	0.26	0.63	0.57	1.04	0.45	A251*
42	2.28	0.82	1.15	0.72	0.91	0.52	A252
30	2.08	0.74	1.04	0.72	0.91	0.52	A253
18	1.88	0.66	0.93	0.73	0.92	0.52	A254
04	1.66	0.58	0.81	0.74	0.93	0.52	A255
90	1.42	0.49	0.69	0.74	0.94	0.53	A256
74	1.17	0.40	0.56	0.75	0.95	0.53	A257
67	1.92	0.47	1.00	0.55	0.92	0.43	A258*
61	1.73	0.42	0.89	0.55	0.93	0.43	A259*
54	1.53	0.37	0.78	0.56	0.94	0.43	A260*
47	1.32	0.32	0.66	0.57	0.95	0.43	A261*
39	1.09	0.25	0.54	0.57	0.95	0.43	A262*
64	1.14	0.46	0.70	0.56	0.75	0.42	A264
58	1.03	0.41	0.62	0.57	0.76	0.42	A265
51	0.91	0.36	0.55	0.58	0.77	0.42	A266
45	0.79	0.31	0.47	0.58	0.78	0.42	A267
37	0.65	0.25	0.38	0.59	0.78	0.42	A268
29	0.51	0.20	0.29	0.60	0.79	0.43	A269
26	0.75	0.26	0.54	0.40	0.68	0.39	A270*
24	0.68	0.23	0.48	0.41	0.69	0.39	A271*
21	0.61	0.20	0.42	0.41	0.69	0.39	A272*
19	0.53	0.17	0.36	0.42	0.70	0.40	A273*
16	0.44	0.14	0.30	0.42	0.71	0.40	A274*
12	0.34	0.11	0.23	0.43	0.72	0.40	A275*
12	0.37	0.12	0.23	0.39	0.63	0.30	A276*
09	0.24	0.09	0.18	0.40	0.63	0.31	A277*
04	0.09	0.05	0.09	0.27	0.41	0.22	A278*
02	0.05	0.03	0.05	0.29	0.44	0.22	A279*

Angles marked * are special

PROPERTIES OF STANDARD AND SPECIAL ANGLES

ANGLES WITH EQUAL LEGS

1	2	3	4	5	6	7	8	9	1
Section Index	Size Inches	Thickness, Inches	Weight per Foot Pounds	Area of Section Square Inches	Distance of Center of Gravity from Back of Flange, Inches	Moment of Inertia, Neutral Axis through Center of Gravity Parallel to Flange I	Section Modulus, Neutral Axis as before S	Radius of Gyration, Neutral Axis as before r	Least Radius of Gyration, Neutral Axis r
A113	8 x8	1⅛	56.9	16.73	2.41	97.97	17.53	2.42	1.
A112	8 x8	1 1/16	54.0	15.87	2.39	93.53	16.67	2.43	1.
A111	8 x8	1	51.0	15.00	2.37	88.98	15.80	2.44	1.
A110	8 x8	15/16	48.1	14.12	2.34	84.33	14.91	2.44	1.
A109	8 x8	⅞	45.0	13.23	2.32	79.58	14.01	2.45	1.
A108	8 x8	13/16	42.0	12.34	2.30	74.71	13.11	2.46	1.
A107	8 x8	¾	38.9	11.44	2.28	69.74	12.18	2.47	1.
A106	8 x8	11/16	35.8	10.53	2.25	64.64	11.25	2.48	1.
A105	8 x8	⅝	32.7	9.61	2.23	59.42	10.30	2.49	1.
A104	8 x8	9/16	29.6	8.68	2.21	54.09	9.34	2.50	1.
A103	8 x8	½	26.4	7.75	2.19	48.63	8.37	2.50	1.
A 86	6 x6	1	37.4	11.00	1.86	35.46	8.57	1.80	1.
A 87	6 x6	15/16	35.3	10.37	1.84	33.72	8.11	1.80	1.
A 1	6 x6	⅞	33.1	9.74	1.82	31.92	7.64	1.81	1.
A 2	6 x6	13/16	31.0	9.09	1.80	30.06	7.15	1.82	1.
A 3	6 x6	¾	28.7	8.44	1.78	28.15	6.66	1.83	1.
A 4	6 x6	11/16	26.5	7.78	1.75	26.19	6.17	1.83	1.
A 5	6 x6	⅝	24.2	7.11	1.73	24.16	5.66	1.84	1.
A 6	6 x6	9/16	21.9	6.43	1.71	22.07	5.14	1.85	1.
A 7	6 x6	½	19.6	5.75	1.68	19.91	4.61	1.86	1.
A 8	6 x6	7/16	17.2	5.06	1.66	17.68	4.07	1.87	1.
A 88	6 x6	⅜	14.9	4.36	1.64	15.39	3.53	1.88	1.
*A 94	5 x5	1	30.6	9.00	1.61	19.64	5.80	1.48	0.
*A 95	5 x5	15/16	28.9	8.50	1.59	18.71	5.49	1.48	0.
*A 9	5 x5	⅞	27.2	7.99	1.57	17.75	5.17	1.49	0.
*A 10	5 x5	13/16	25.4	7.46	1.55	16.77	4.85	1.50	0.
*A 11	5 x5	¾	23.6	6.94	1.52	15.74	4.53	1.51	0.
*A 12	5 x5	11/16	21.8	6.42	1.50	14.68	4.20	1.51	0.
*A 13	5 x5	⅝	20.0	5.86	1.48	13.58	3.86	1.52	0.
*A 14	5 x5	9/16	18.1	5.31	1.46	12.44	3.51	1.53	0.
*A 15	5 x5	½	16.2	4.75	1.43	11.25	3.15	1.54	0.
*A 16	5 x5	7/16	14.3	4.18	1.41	10.02	2.79	1.55	0.
*A 17	5 x5	⅜	12.3	3.61	1.39	8.74	2.42	1.56	0.
A 18	4 x4	13/16	19.9	5.84	1.29	8.14	3.01	1.18	0.
A 19	4 x4	¾	18.5	5.44	1.27	7.67	2.81	1.19	0.

Angles marked * are special

PROPERTIES OF STANDARD AND SPECIAL ANGLES—Continued

ANGLES WITH EQUAL LEGS

1	2	3	4	5	6	7	8	9	10
Section Index	Size Inches	Thickness, Inches	Weight per Foot Pounds	Area of Section Square Inches	Distance of Center of Gravity from Back of Flange, Inches	Moment of Inertia, Neutral Axis through Center of Gravity Parallel to Flange I	Section Modulus Neutral Axis as before S	Radius of Gyration Neutral Axis as before r	Least Radius of Gyration, Neutral Axis through Center of Gravity at Angle of 45 Degrees to Flanges r′
A 20	4 x4	$\frac{11}{16}$	17.1	5.03	1.25	7.17	2.61	1.19	0.77
A 21	4 x4	$\frac{5}{8}$	15.7	4.61	1.23	6.66	2.40	1.20	0.77
A 22	4 x4	$\frac{9}{16}$	14.3	4.18	1.21	6.12	2.19	1.21	0.78
A 23	4 x4	$\frac{1}{2}$	12.8	3.75	1.18	5.56	1.97	1.22	0.78
A 24	4 x4	$\frac{7}{16}$	11.3	3.31	1.16	4.97	1.75	1.23	0.78
A 25	4 x4	$\frac{3}{8}$	9.8	2.86	1.14	4.36	1.52	1.23	0.79
A 90	4 x4	$\frac{5}{16}$	8.2	2.40	1.12	3.71	1.29	1.24	0.79
A 26	3½x3½	$\frac{13}{16}$	17.1	5.03	1.17	5.25	2.25	1.02	0.67
A 27	3½x3½	$\frac{3}{4}$	16.0	4.69	1.15	4.96	2.11	1.03	0.67
A 28	3½x3½	$\frac{11}{16}$	14.8	4.34	1.12	4.65	1.96	1.04	0.67
A 29	3½x3½	$\frac{5}{8}$	13.6	3.98	1.10	4.33	1.81	1.04	0.67
A 30	3½x3½	$\frac{9}{16}$	12.4	3.62	1.08	3.99	1.65	1.05	0.68
A 31	3½x3½	$\frac{1}{2}$	11.1	3.25	1.06	3.64	1.49	1.06	0.68
A 32	3½x3½	$\frac{7}{16}$	9.8	2.87	1.04	3.26	1.32	1.07	0.68
A 33	3½x3½	$\frac{3}{8}$	8.5	2.48	1.01	2.87	1.15	1.07	0.69
A 99	3½x3½	$\frac{5}{16}$	7.2	2.09	0.99	2.45	0.98	1.08	0.69
A 34	3 x3	$\frac{5}{8}$	11.5	3.36	0.98	2.62	1.30	0.88	0.57
A 35	3 x3	$\frac{9}{16}$	10.4	3.06	0.95	2.43	1.19	0.89	0.58
A 36	3 x3	$\frac{1}{2}$	9.4	2.75	0.93	2.22	1.07	0.90	0.58
A 37	3 x3	$\frac{7}{16}$	8.3	2.43	0.91	1.99	0.95	0.91	0.58
A 38	3 x3	$\frac{3}{8}$	7.2	2.11	0.89	1.76	0.83	0.91	0.58
A 39	3 x3	$\frac{5}{16}$	6.1	1.78	0.87	1.51	0.71	0.92	0.59
A 40	3 x3	$\frac{1}{4}$	4.9	1.44	0.84	1.24	0.58	0.93	0.59
*A 41	2¾x2¾	$\frac{1}{2}$	8.5	2.50	0.87	1.67	0.89	0.82	0.52
*A 42	2¾x2¾	$\frac{7}{16}$	7.6	2.22	0.85	1.51	0.79	0.82	0.53
*A 43	2¾x2¾	$\frac{3}{8}$	6.6	1.92	0.82	1.33	0.69	0.83	0.53
*A 44	2¾x2¾	$\frac{5}{16}$	5.6	1.62	0.80	1.15	0.59	0.84	0.54
*A 45	2¾x2¾	$\frac{1}{4}$	4.5	1.31	0.78	0.93	0.48	0.85	0.55
A 46	2½x2½	$\frac{1}{2}$	7.7	2.25	0.81	1.23	0.73	0.74	0.47
A 47	2½x2½	$\frac{7}{16}$	6.8	2.00	0.78	1.11	0.65	0.74	0.48
A 48	2½x2½	$\frac{3}{8}$	5.9	1.73	0.76	0.98	0.57	0.75	0.48
A 49	2½x2½	$\frac{5}{16}$	5.0	1.47	0.74	0.85	0.48	0.76	0.49
A 50	2½x2½	$\frac{1}{4}$	4.1	1.19	0.72	0.70	0.40	0.77	0.49
A100	2½x2½	$\frac{3}{16}$	3.1	0.90	0.69	0.55	0.30	0.78	0.49

Angles marked * are special

PROPERTIES OF STANDARD AND SP

ANGLES—Continued

ANGLES WITH EQUAL LEGS

1	2	3	4	5	6	7	8	9
Section Index	Size Inches	Thickness, Inches	Weight per Foot Pounds	Area of Section Square Inches	Distance of Center of Gravity from Back of Flange, Inches	Moment of Inertia, Neutral Axis through Center of Gravity Parallel to Flange I	Section Modulus Neutral Axis as before S	Radius of Gyration Neutral Axis as r
*A 51	2¼x2¼	½	6.8	2.00	0.74	0.87	0.58	0.6
*A 52	2¼x2¼	7/16	6.1	1.78	0.72	0.79	0.52	0.67
*A 53	2¼x2¼	⅜	5.3	1.55	0.70	0.70	0.45	0.67
*A 54	2¼x2¼	5/16	4.5	1.31	0.68	0.61	0.39	0.6
*A 55	2¼x2¼	¼	3.7	1.06	0.66	0.51	0.32	0.6
*A101	2¼x2¼	3/16	2.8	0.81	0.63	0.39	0.24	0.7
A 56	2 x2	7/16	5.3	1.56	0.66	0.54	0.40	0.5
A 57	2 x2	⅜	4.7	1.36	0.64	0.48	0.35	0.5
A 58	2 x2	5/16	4.0	1.15	0.61	0.42	0.30	0.6
A 59	2 x2	¼	3.2	0.94	0.59	0.35	0.25	0.61
A 60	2 x2	3/16	2.5	0.72	0.57	0.28	0.19	0.6
A 61	1¾x1¾	7/16	4.6	1.30	0.59	0.35	0.30	0.51
A 62	1¾x1¾	⅜	4.0	1.17	0.57	0.31	0.26	0.51
A 63	1¾x1¾	5/16	3.4	1.00	0.55	0.27	0.23	0.5
A 64	1¾x1¾	¼	2.8	0.81	0.53	0.23	0.19	0.5
A 65	1¾x1¾	3/16	2.2	0.62	0.51	0.18	0.14	0.5
A 66	1½x1½	⅜	3.4	0.99	0.51	0.19	0.19	0.4
A 67	1½x1½	5/16	2.9	0.84	0.49	0.16	0.162	0.4
A 68	1½x1½	¼	2.4	0.69	0.47	0.14	0.134	0.4
A 69	1½x1½	3/16	1.8	0.53	0.44	0.11	0.104	0.4
A102	1½x1½	⅛	1.3	0.36	0.42	0.08	0.070	0.4
A 70	1¼x1¼	5/16	2.4	0.69	0.42	0.09	0.109	0.3
A 71	1¼x1¼	¼	2.0	0.56	0.40	0.077	0.091	0.37
A 72	1¼x1¼	3/16	1.5	0.43	0.38	0.061	0.071	0.3
A 73	1¼x1¼	⅛	1.1	0.30	0.35	0.044	0.049	0.3
A 78	1 x1	¼	1.5	0.44	0.34	0.037	0.056	0.2
A 79	1 x1	3/16	1.2	0.34	0.32	0.030	0.044	0.3
A 80	1 x1	⅛	0.8	0.24	0.30	0.022	0.031	0.31
*A 81	⅞x ⅞	3/16	1.0	0.29	0.29	0.019	0.033	0.2
*A 82	⅞x ⅞	⅛	0.7	0.21	0.26	0.014	0.023	0.2
A 83	¾x ¾	3/16	0.9	0.25	0.26	0.012	0.024	0.2
A 84	¾x ¾	⅛	0.6	0.17	0.23	0.009	0.017	0.2

Angles marked * are special

EIGHTS AND DIMENSIONS OF AMERICAN STANDARD RAIL SECTIONS

	Weight per Yard in Pounds	Area in Square Inches	Width of Base and Height in Inches	Web in Inches	Width of Head in Inches	y Height of Center of Gravity above Base in Inches	AXIS x—x		
							Moment of Inertia I	Section Modulus S	Radius of Gyration r
A	100	9.8	$5\frac{3}{4}$	$\frac{9}{16}$	$2\frac{3}{4}$	2.8	43.8	14.6	2.13
A	95	9.3	$5\frac{9}{16}$	$\frac{9}{16}$	$2\frac{11}{16}$	2.7	38.6	13.3	2.06
A	90	8.8	$5\frac{3}{8}$	$\frac{9}{16}$	$2\frac{5}{8}$	2.5	34.0	12.0	1.97
A	85	8.3	$5\frac{3}{16}$	$\frac{9}{16}$	$2\frac{9}{16}$	2.5	30.0	11.0	1.90
A	80	7.8	5	$\frac{35}{64}$	$2\frac{1}{2}$	2.4	26.2	10.0	1.83
A	75	7.4	$4\frac{13}{16}$	$\frac{17}{32}$	$2\frac{15}{32}$	2.4	22.9	9.3	1.78
A	70	6.9	$4\frac{5}{8}$	$\frac{33}{64}$	$2\frac{7}{16}$	2.2	19.6	8.2	1.70
A	65	6.4	$4\frac{7}{16}$	$\frac{1}{2}$	$2\frac{13}{32}$	2.2	16.9	7.4	1.63
A	60	5.9	$4\frac{1}{4}$	$\frac{31}{64}$	$2\frac{3}{8}$	2.1	14.5	6.7	1.58
A	55	5.4	$4\frac{1}{16}$	$\frac{15}{32}$	$2\frac{1}{4}$	2.0	11.9	5.8	1.49
A	50	4.9	$3\frac{7}{8}$	$\frac{7}{16}$	$2\frac{1}{8}$	1.9	9.8	4.9	1.42
A	45	4.4	$3\frac{11}{16}$	$\frac{27}{64}$	2	1.8	8.0	4.2	1.35
A	40	3.9	$3\frac{1}{2}$	$\frac{25}{64}$	$1\frac{7}{8}$	1.7	6.6	3.6	1.30
A	35	3.4	$3\frac{1}{4}$	$\frac{23}{64}$	$1\frac{3}{4}$	1.6	4.8	2.8	1.19
A	30	3.0	3	$\frac{21}{64}$	$1\frac{5}{8}$	1.4	3.5	2.3	1.11
A	25	2.5	$2\frac{3}{4}$	$\frac{19}{64}$	$1\frac{1}{2}$	1.3	2.4	1.7	.99
A	20	2.0	$2\frac{1}{2}$	$\frac{17}{64}$	$1\frac{3}{8}$	1.2	1.7	1.3	.92
A	16	1.6	$2\frac{1}{4}$	$\frac{15}{64}$	$1\frac{1}{4}$	1.1	1.1	0.97	.84

COLUMNS IN FIREPROOF BUILDINGS

The subject of fireproof construction is steadily growi in importance. The need of fireproof buildings in the bu ness centers of our great cities has been well demonstrat and their superiority has become so generally recognized tl at present but few structures of any size or importance designed which are not more or less of this type. This chan has been facilitated in no small measure by a number signal improvements made of late in the art of fireproof co struction, insuring not only a higher degree of efficiency, b a considerable reduction in cost compared with methods f merly practiced.

The old style of solid brick arch, once so prevalent in flo construction, has been almost wholly supplanted by the mo modern forms of hollow tile and terra cotta arches. The i portant advantages of the latter have been already pointed in these pages. Roofs, ceilings and partition walls are n also largely constructed of these light refractory materials.

The substitution of steel for iron in beams may be cited a radical improvement in this direction, and, simultaneous the introduction by this firm of new patterns for its st beams. These patterns are of more convenient shape a much more economical of material than the old forms.

Another change which is gradually taking place is substitution of steel for cast iron in the composition of colum Cast iron is a material so uncertain in character that its has long since been abandoned in bridge construction. buildings the loads are generally quiescent and the liability sudden shocks is more remote than in bridges; yet, on other hand, the columns seldom receive their loads as fav ably as in bridges; in most cases there exists considera eccentricity, that is, the loads on one side of the column heavier than those on the other side, and the bending stra arising therefrom increase the strains from direct compress materially.

The following are some of the contingencies which may arise in the manufacture of castings and which preclude anything approaching uniformity in the product.

In the case of hollow cast iron columns, while the metal is yet in a molten state the buoyancy of the central core tends to cause it to rise, thereby reducing the thickness of the metal above and increasing it below. When columns are of such a length as to make it necessary to pour the metal into the mould from both ends, it sometimes occurs that the iron becomes too much chilled on the surface to properly mix and unite, thus creating a weak seam at the very point where the greatest strength will be needed. The presence of confined air, producing "blowholes" and "honeycomb," and the collection of impurities at the bottom of the mould may be further mentioned as frequent sources of weakness in cast iron.

The most critical condition, however, is that due to the unequal contraction of the metal during the process of cooling, thereby giving rise to initial stresses, at times of sufficient force to produce rupture in the column or in its lugs on the slightest provocation. In many cases the trouble can be ascribed to faulty designing or carelessness in the execution of the work, yet even under favorable conditions it is so difficult to secure equal radiation from the moulds in all directions that castings entirely exempt from inherent shrinkage strains are probably seldom produced.

As a protection against these contingencies resort must be had either to the crude and uncertain expedient of a high safety factor, not less than 8 or 10, or a material such as rolled steel must be adopted of a more uniform and reliable character than cast iron.

Steel Columns fail either by deflecting bodily out of a straight line, or by the buckling of the metal between rivets or other points of support. Both actions may take place at the same time, but if the latter occurs alone, it may be an indication that the rivet spacing or the thickness of the metal is insufficient.

The rule has been deduced from actual experiments upon *wrought iron columns,* that the distance between centers of

rivets should not exceed in the line of strain sixteen tim
thickness of metal of the parts joined, and that the di
between rivets or other points of support at right angles
line of strain should not exceed thirty-two times the thi
of the metal.

On page 51 sections are shown of some of the most co
forms of built columns. Figs. 6, 13 and 19 belong to th
known as "Closed Columns." As it is impracticable to r
the inner surfaces of such columns, they should prefera
used only for interior work, where the changes in tempe
are not considerable, and the air is comparatively dr
places exposed to extremes of temperature and unpro
from the rain, the paint on the inner surface of the colum
sooner or later, cease to be a protection; corrosion will
and, once begun, is apt to continue as long as there is
dized metal left in the column.

The remaining figures on the same page represent
of columns with open sections, which readily admit of re
ing, and are, therefore, suitable for outdoor work.

Of these, Figs. 14, 15, 16, 17 and 18, which are kno
Z-bar columns, have been shown by extended use to b
ticularly well adapted to many purposes in construction.

In the use of columns of the types shown in Figs. 5,
10 and 12, care should be taken in designing that the f
are placed sufficiently far apart to permit machine-driv
the rivets.

The Z-bar and channel columns are particularl
adapted for buildings, owing to their facility for eff
connection with floor beams and girders.

The advantage of the constant dimension Z-bar c
lies in the quicker preparation of plans and subsequen
details, the outside dimensions being the same througho
successive stories of the structure, making a guide f
architect in dimensioning walls and pillars, and facilitati
work of the engineer in the preparation of shop details,
are the same for all typical floors.

Standard bases, which can be adapted to any sect
column, are shown on page 50, Figs. 4, 5 and 6 showin
iron, and Figs. 7 and 8 the built-up type.

Connections for floor beams to constant dimension Z-bar umns, detailed on pages 189 and 190, were designed to fairly ver the range of ordinary practice. For other types of lumns, the make-up of these details should be altered to it the conditions governing, but, in a general way, they dicate the standard practice.

When the maximum loads in tons, as assumed for each se, are exceeded, the connections must be correspondingly rengthened by using longer vertical angles for the brackets, : by other suitable detail that will provide for the correct umber of rivets. In proportioning these connections the bearing stress on rivets was assumed of a maximum intensity f 10,000 pounds per square inch.

In buildings, as a rule, the columns are permanently encased in a fireproofing composition. On page 50, Figs. 1, 2 and 3, are shown designs of fireproofing for Z-bar columns, giving the latter a cylindrical, or a rectangular finish with rounded corners, as may be preferred. Similar casings can be used for any other type of built-up column, the air space between the tiling and the metal adding to the protection of the latter in the event of fire.

Complete tables of dimensions and safe loads in tons for columns of different lengths are given on pages 127 to 136, inclusive, covering the constant dimension as well as the other type of Z-bar columns, and on pages 137 to 142 covering plate and channel and latticed channel columns.

The length of a column unbraced should not exceed 125 times its least radius of gyration.

We believe the variety given in these tables will cover a large majority of the cases presenting themselves in ordinary practice.

COLUMNS AND STRUTS

Explanation of Tables, pages 127 to 149 inclusive.

The tables of safe loads for steel Z-bar and channel columns a piled on the basis of an allowable stress per square inch of 12,000 (factor of safety of 4) for lengths of 90 radii and under, and an all stress deduced from the formula $17{,}100-57\frac{l}{r}$ for lengths great this limit.

Complete dimensions of the Z-bar columns are given opposi tables of safe loads.

The steel used in these columns is known as "medium" ste taining a comparatively low percentage of carbon.

The values given in these tables should be used only for which the loads are for the most part statical, and equal, or ne on opposite sides of the column. When there is much eccentr loading, or the loads are subject to a sudden change, the ta values should be reduced according to circumstances.

The table on the "Ultimate Strength of Columns," on page 14 the stress per square inch of section at which columns will fail for proportions of length, in feet, to least radius of gyration, in inche table is based on Gordon's formula changed for the use of stee table on page 147, showing the radii of gyration for round and columns, will be found useful in connection with this table.

If the column or strut is a single rolled beam, channel or other the radius of gyration will be found in the foregoing tables on pag 119 inclusive.

If the column is composed of two channels latticed, the chann usually placed far enough apart so that the column will be wea the direction of the web, *i. e.*, with neutral axis at right angles web, for which case the radius of gyration of the column is the s that of the single channel. In the table of "Properties of St Channels," page 102, are given the distances back to back of ch which make the radii equal about both axes.

A common form of column or strut, to be recommended fo paratively light loads, is that formed of two angles back to back, angles united either with a single course of lattice bars or a cent plate, as in Fig. 1, page 51.

The radii of gyration for such struts are tabulated on pages and 146. They are given for the neutral axis parallel to either fla for minimum and maximum sizes of all standard and special ang In cases where four angles are used, the two pairs should be spa enough apart to make the column weakest about a neutral axis to the central web or latticing. The radius of gyration will then same as that given in the tables for a single pair of angles, si moment of inertia of the web plate about such an axis is so smal may be disregarded entirely.

The table on "Ultimate Strength of Hollow Cast Iron Columns" and that on "Safe Loads for Hollow Round Cast Iron Columns" were computed by Gordon's formula and cover a range of length that will seldom be exceeded in practice.

A column is *square bearing* when it has square ends which butt against or are firmly connected with an immovable surface, such as the floor of a building; it is *pin and square bearing* when one end only is square bearing and the other presses against a close-fitting pin; and it is *pin bearing* when both ends are thus pin-jointed with the axis of the pins in parallel directions (for example, the posts in pin-connected bridges).

EXAMPLES

I. What size of constant dimension Z-bar column 24 ft. long with square bearing ends will be required to carry a load of 300 tons, using a safety factor of 4?

Answer: From the table on page 135 it will be seen that for the length given 4Z[s] $4\frac{1}{8} \times 3\frac{7}{16} \times \frac{3}{4}$ with 2 web plates $8 \times 1\frac{1}{2}$ will sustain 306.0 tons, which is 6 tons in excess of that required, or referring to table on channel columns, page 141, two 10 in. channels 35 lbs. and 2 side plates $12 \times 1\frac{1}{4}$ will be found sufficiently strong.

II. A strut 16 ft. long, fixed rigidly at both ends, is needed for supporting a load of 80,000 lbs. It is to be composed of two pairs of angles united with a single line of $\frac{1}{4}$ in. lattice bars along the central plane. What weight of angles will be required with a safety factor of 5?

Answer: We will assume four 3×4 in. angles and determine the thickness of metal required. The angles must be spread $\frac{1}{2}$ in. in order to admit the latticing. From the table on page 146 we find the radius of gyration of a pair of $3 \times 4 \times \frac{5}{16}$ in. angles with the 3 in. legs parallel and $\frac{1}{2}$ in. apart to be 1.97 in. Hence the value of $\frac{1}{r} = \frac{16}{1.97} = 8.1$, for which the ultimate strength as per table on page 143 = 39,600 lbs.

The allowable strain per square inch with a safety factor of 5 will therefore be $39{,}600 \div 5 = 7{,}920$ lbs. and the area of the required cross-section $80{,}000 \div 7{,}920 = 10.10$ square inches, or 2.52 square inches for each angle. Hence the weight per foot of each angle will be $2.52 \times 3.4 = 8.6$ lbs. This weight will be found to agree nearly with a thickness of $\frac{7}{16}$ in. for a 4×3 in. angle.

SAFE LOADS IN TONS OF 2,000 LBS.

Z-BAR COLUMNS

SQUARE ENDS

Allowed stresses per square inch; safety factor 4 { 12,000 lbs. for lengths of 90 radii or under; $17{,}000-57\frac{l}{r}$ for lengths over 90 radii

6 IN. Z-BAR COLUMNS

Section: 4 Z-Bars 3 in. deep and 1 Web Plate 6 in. × thickness of Z-Bars

Length of Column in Feet	1/4 Metal=31.7 lbs.=9.31 sq. in. r (min.)=1.86	5/16 Metal=39.8 lbs.=11.7 sq. in. r (min.)=1.90	3/8 Metal=46.2 lbs.=13.6 sq. in. r (min.)=1.88	7/16 Metal=54.3 lbs.=16.0 sq. in. r (min.)=1.93	1/2 Metal=59.9 lbs.=17.6 sq. in. r (min.)=1.90	9/16 Metal=67.9 [illegible]
12 and under	55.9	70.3	81.6	95.8	105.7	11[illegible]
14	55.7	70.3	81.6	95.8	105.7	11[illegible]
16	52.3	66.5	76.6	91.3	99.9	11[illegible]
18	48.8	62.3	71.7	85.6	93.6	1[illegible]
20	45.4	58.1	66.7	79.9	87.2	1[illegible]
22	42.0	53.9	61.8	74.3	80.9	[illegible]
24	38.6	49 7	56.9	68.6	74.6	[illegible]
26	35.2	45.5	51.9	63.0	68.2	[illegible]
28	31.7	41.3	47.0	57.3	61.9	[illegible]
30	28.3	37.1	42.0	51.7	55.5	[illegible]

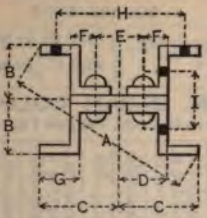
8 IN. Z-BAR COLUMNS

Section: 4 Z-Bars 4 in. deep and 1 Web Plate 7 in. × thickness of Z-Bars

Length of Column in Feet	1/4 Metal=38.3 lbs.=11.3 sq. in. r (min.)=2.47	5/16 Metal=48.1 lbs.=14.1 sq. in. r (min.)=2.52	3/8 Metal=58.0 lbs.=17.1 sq. in. r (min.)=2.57	7/16 Metal=64.7 lbs.=19.0 sq. in. r (min.)=2.49	1/2 Metal=74.4 lbs.=21.9 sq. in. r (min.)=2.55	9/16 Metal=84.1 lbs.=24.8 sq. in. r (min.)=2.60	5/8 Metal=89.2 lbs.=26.3 sq. in. r (min.)=2.52	11/16 Metal=98.8 lbs.=29.0 sq. in. r (min.)=2.58
18 and under	67.5	84.8	102.4	114.2	131.2	148.5	157.5	174.3
20	65.0	82.5	100.5	110.5	128.2	146.4	153.3	171.3
22	61.9	78.7	95.9	105.3	122.4	139.9	146.2	163.5
24	58.8	74.8	91.3	100.1	116.5	133.4	139.1	155.8
26	55.7	71.0	86.8	94.8	110.6	126.9	132.0	148.1
28	52.6	67.1	82.3	89.6	104.7	120.3	124.8	140.4
30	49.4	63.3	77.7	84.4	98.8	113.8	117.7	132.7
32	46.3	59.5	73.2	79.2	93.0	107.3	110.6	125.0
34	43.2	55.6	68.7	74.0	87.1	100.8	103.5	117.3
36	40.1	51.8	64.1	68.7	81.2	94.3	96.4	109.6
38	37.0	48.0	59.6	63.5	75.3	87.8	89.4	101.9
40	33.9	44.1	55.0	58.3	69.5	81.3	82.2	94.2

To the above weights of column shafts add the weight of ri

Z-BAR COLUMN DIMENSIONS



6 IN. COLUMNS

4 Z-Bars 3-3$\frac{1}{16}$ in. deep

1 Web Plate 6 in. × Thickness of Z-Bars

Thickness of Metal	A	B	C	D	E	F	G	H	I
$\frac{1}{4}$	$12\frac{3}{4}$	$3\frac{1}{8}$	$5\frac{9}{16}$	$3\frac{1}{8}$	3	$1\frac{5}{8}$	$2\frac{11}{16}$	$8\frac{1}{2}$	$3\frac{1}{4}$
$\frac{5}{16}$	$12\frac{7}{8}$	$3\frac{7}{32}$	$5\frac{9}{16}$	$3\frac{1}{8}$	3	$1\frac{5}{8}$	$2\frac{3}{4}$	$8\frac{1}{2}$	$3\frac{3}{8}$
$\frac{3}{8}$	$12\frac{5}{8}$	$3\frac{3}{16}$	$5\frac{7}{16}$	$3\frac{1}{8}$	3	$1\frac{5}{8}$	$2\frac{11}{16}$	$8\frac{1}{2}$	$3\frac{3}{8}$
$\frac{7}{16}$	$12\frac{11}{16}$	$3\frac{9}{32}$	$5\frac{7}{16}$	$3\frac{1}{8}$	3	$1\frac{5}{8}$	$2\frac{3}{4}$	$8\frac{1}{2}$	$3\frac{1}{2}$
$\frac{1}{2}$	$12\frac{7}{16}$	$3\frac{1}{4}$	$5\frac{5}{16}$	$3\frac{1}{8}$	3	$1\frac{5}{8}$	$2\frac{11}{16}$	$8\frac{1}{2}$	$3\frac{1}{2}$
$\frac{9}{16}$	$12\frac{9}{16}$	$3\frac{11}{32}$	$5\frac{5}{16}$	$3\frac{1}{8}$	3	$1\frac{5}{8}$	$2\frac{3}{4}$	$8\frac{1}{2}$	$3\frac{5}{8}$

8 IN. COLUMNS

4 Z-Bars 4-4$\frac{1}{8}$ in. deep

1 Web Plate 7 in. × Thickness of Z-Bars

Thickness of Metal	A	B	C	D	E	F	G	H	I
$\frac{1}{4}$	$15\frac{5}{16}$	$4\frac{1}{8}$	$6\frac{7}{16}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$1\frac{7}{8}$	$3\frac{1}{16}$	10	$4\frac{1}{4}$
$\frac{5}{16}$	$15\frac{3}{8}$	$4\frac{7}{32}$	$6\frac{7}{16}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$1\frac{7}{8}$	$3\frac{1}{8}$	10	$4\frac{3}{8}$
$\frac{3}{8}$	$15\frac{1}{2}$	$4\frac{5}{16}$	$6\frac{7}{16}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$1\frac{7}{8}$	$3\frac{3}{16}$	10	$4\frac{1}{2}$
$\frac{7}{16}$	$15\frac{1}{16}$	$4\frac{7}{32}$	$6\frac{1}{4}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$1\frac{7}{8}$	$3\frac{1}{16}$	10	$4\frac{7}{16}$
$\frac{1}{2}$	$15\frac{3}{16}$	$4\frac{5}{16}$	$6\frac{1}{4}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$1\frac{7}{8}$	$3\frac{1}{8}$	10	$4\frac{9}{16}$
$\frac{9}{16}$	$15\frac{5}{16}$	$4\frac{13}{32}$	$6\frac{1}{4}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$1\frac{7}{8}$	$3\frac{3}{16}$	10	$4\frac{11}{16}$
$\frac{5}{8}$	$14\frac{7}{8}$	$4\frac{5}{16}$	$6\frac{1}{16}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$1\frac{7}{8}$	$3\frac{1}{16}$	10	$4\frac{5}{8}$
$\frac{11}{16}$	15	$4\frac{13}{32}$	$6\frac{1}{16}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$1\frac{7}{8}$	$3\frac{1}{8}$	10	$4\frac{3}{4}$
$\frac{3}{4}$	$15\frac{1}{8}$	$4\frac{1}{2}$	$6\frac{1}{16}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$1\frac{7}{8}$	$3\frac{3}{16}$	10	$4\frac{7}{8}$

SAFE LOADS IN TONS OF 2,000 LBS.

Z-BAR COLUMNS

SQUARE ENDS

Allowed stresses per square inch; safety factor 4 — 12,000 lbs. for lengths of 90 radii or und
$17100-57\frac{l}{r}$ for lengths over 90 radii

10 IN. Z-BAR COLUMNS

Section: 4 Z-Bars 5 in. deep and 1 Web Plate 7 in. × thickness of Z-Bars

Length of Column in Feet	5/16 Metal=53.7 lbs.=15.8 sq. in. r (min.)=3.08	3/8 Metal=64.7 lbs.=19.0 sq. in. r (min.)=3.13	7/16 Metal=75.8 lbs.=22.3 sq. in. r (min.)=3.18	1/2 Metal=83.3 lbs.=24.5 sq. in. r (min.)=3.10	9/16 Metal=94.2 lbs.=27.7 sq. in. r (min.)=3.15	5/8 Metal=105.2 lbs.=30.9 sq. in. r (min.)=3.21	11/16 Metal=111.0 lbs.=32.7 sq. in. r (min.)=3.13	3/4 Metal=121.8 lbs.=35.8 sq. in. r (min.)=3.18
22 and under	94.7	114.2	133.9	147.0	166.2	185.6	196.0	214.
24	92.8	112.6	133.1	144.6	164.8	185.3	193.6	213.
26	89.3	108.6	128.3	139.2	158.7	178.7	186.5	206.
28	85.8	104.4	123.5	133.8	152.7	172.1	179.3	198.
30	82.3	100.2	118.7	128.4	146.7	165.5	172.2	190.
32	78.8	96.1	113.8	123.0	140.7	158.9	165.0	183.
34	75.3	91.9	109.1	117.6	134.7	152.3	157.9	175.
36	71.8	87.8	104.3	112.2	128.7	145.7	150.7	167.
38	68.3	83.6	99.5	106.8	122.7	139.1	143.6	160.
40	64.8	79.4	94.7	101.4	116.7	132.5	136.5	152.
42	61.3	75.3	89.9	96.0	110.6	125.9	129.4	144.
44	57.7	71.1	85.1	90.6	104.6	119.3	122.2	136.
46	54.2	67.0	80.3	85.2	98.6	112.7	115.1	129.
48	50.7	62.8	75.5	79.8	92.6	106.1	107.9	121.
50	47.2	58.6	70.7	74.4	86.6	99.5	100.8	113.

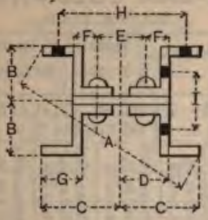
12 IN. Z-BAR COLUMNS

Section: 4 Z-Bars 6 in. deep and 1 Web Plate 8 in. × thickness of Z-Bars

Length of Column in Feet	3/8 Metal=72.7 lbs.=21.4 sq. in. r (min.)=3.67	7/16 Metal=85.2 lbs.=25.0 sq. in. r (min.)=3.72	1/2 Metal=97.8 lbs.=28.8 sq. in. r (min.)=3.77	9/16 Metal=106.2 lbs.=31.2 sq. in. r (min.)=3.70	5/8 Metal=118.5 lbs.=34.8 sq. in. r (min.)=3.75	11/16 Metal=130.9 lbs.=38.5 sq. in. r (min.)=3.73	3/4 Metal=137.8 lbs.=40.5 sq. in. r (min.)=3.68	13/16 Metal=149.9 lbs.=44.1 sq. in. r (min.)=3.66
26 and under	128.3	150.3	172.6	187.3	209.1	231.0	243.0	264.
28	127.0	149.7	172.5	186.0	208.9	230.3	240.8	261.
30	123.0	145.1	167.6	180.2	202.5	223.3	233.2	253.
32	119.0	140.5	162.4	174.5	196.1	216.3	225.7	245.
34	115.1	135.9	157.2	168.7	189.8	209.2	218.2	236.
36	111.1	131.3	152.0	162.9	183.4	202.1	210.6	228.
38	107.1	126.7	146.8	157.1	177.0	195.1	203.1	220.
40	103.1	122.1	141.5	151.4	170.7	188.0	195.6	211.
42	99.1	117.5	136.3	145.5	164.4	180.9	188.0	203.
44	95.1	112.9	131.1	139.8	158.0	173.9	180.5	195.
46	91.2	108.3	126.2	134.0	151.6	166.8	172.9	187.
48	87.2	103.6	120.7	128.2	145.3	159.8	165.4	179.
50	83.2	99.1	115.5	122.4	138.9	152.7	157.9	170.

To the above weights of column shafts add the weight of r

Z-BAR COLUMN DIMENSIONS



10 IN. COLUMNS

4 Z-Bars 5—5⅛ in. deep

1 Web Plate 7 in. × thickness of Z-Bars

Diameter of Bolt or Rivet, ¾ in.

Thickness of Metal	A	B	C	D	E	F	G	H	I
$\frac{5}{16}$	$16\frac{11}{16}$	$5\frac{5}{32}$	$6\frac{9}{16}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$1\frac{7}{8}$	$3\frac{1}{4}$	10	$5\frac{5}{16}$
$\frac{3}{8}$	$16\frac{13}{16}$	$5\frac{1}{4}$	$6\frac{9}{16}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$1\frac{7}{8}$	$3\frac{5}{16}$	10	$5\frac{7}{16}$
$\frac{7}{16}$	$16\frac{15}{16}$	$5\frac{11}{32}$	$6\frac{9}{16}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$1\frac{7}{8}$	$3\frac{3}{8}$	10	$5\frac{9}{16}$
$\frac{1}{2}$	$16\frac{1}{2}$	$5\frac{1}{4}$	$6\frac{3}{8}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$1\frac{7}{8}$	$3\frac{1}{4}$	10	$5\frac{1}{2}$
$\frac{9}{16}$	$16\frac{5}{8}$	$5\frac{11}{32}$	$6\frac{3}{8}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$1\frac{7}{8}$	$3\frac{5}{16}$	10	$5\frac{5}{8}$
$\frac{5}{8}$	$16\frac{3}{4}$	$5\frac{7}{16}$	$6\frac{3}{8}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$1\frac{7}{8}$	$3\frac{3}{8}$	10	$5\frac{3}{4}$
$\frac{11}{16}$	$16\frac{3}{8}$	$5\frac{11}{32}$	$6\frac{3}{16}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$1\frac{7}{8}$	$3\frac{1}{4}$	10	$5\frac{11}{16}$
$\frac{3}{4}$	$16\frac{1}{2}$	$5\frac{7}{16}$	$6\frac{3}{16}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$1\frac{7}{8}$	$3\frac{5}{16}$	10	$5\frac{13}{16}$
$\frac{13}{16}$	$16\frac{5}{8}$	$5\frac{17}{32}$	$6\frac{3}{16}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$1\frac{7}{8}$	$3\frac{3}{8}$	10	$5\frac{15}{16}$

12 IN. COLUMNS

4 Z-Bars 6—6⅛ in. deep

1 Web Plate 8 in. × thickness of Z-Bars

Diameter of Bolt or Rivet, ¾ in.

Thickness of Metal	A	B	C	D	E	F	G	H	I
$\frac{3}{8}$	$19\frac{1}{16}$	$6\frac{3}{16}$	$7\frac{1}{4}$	$4\frac{1}{8}$	4	$2\frac{1}{8}$	$3\frac{1}{2}$	11	$6\frac{3}{8}$
$\frac{7}{16}$	$19\frac{3}{16}$	$6\frac{9}{32}$	$7\frac{1}{4}$	$4\frac{1}{8}$	4	$2\frac{1}{8}$	$3\frac{9}{16}$	11	$6\frac{1}{2}$
$\frac{1}{2}$	$19\frac{5}{16}$	$6\frac{3}{8}$	$7\frac{1}{4}$	$4\frac{1}{8}$	4	$2\frac{1}{8}$	$3\frac{5}{8}$	11	$6\frac{5}{8}$
$\frac{9}{16}$	$18\frac{7}{8}$	$6\frac{9}{32}$	$7\frac{1}{16}$	$4\frac{1}{8}$	4	$2\frac{1}{8}$	$3\frac{1}{2}$	11	$6\frac{9}{16}$
$\frac{5}{8}$	19	$6\frac{3}{8}$	$7\frac{1}{16}$	$4\frac{1}{8}$	4	$2\frac{1}{8}$	$3\frac{9}{16}$	11	$6\frac{11}{16}$
$\frac{11}{16}$	$19\frac{1}{8}$	$6\frac{15}{32}$	$7\frac{1}{16}$	$4\frac{1}{8}$	4	$2\frac{1}{8}$	$3\frac{5}{8}$	11	$6\frac{13}{16}$
$\frac{3}{4}$	$18\frac{3}{4}$	$6\frac{3}{8}$	$6\frac{7}{8}$	$4\frac{1}{8}$	4	$2\frac{1}{8}$	$3\frac{1}{2}$	11	$6\frac{3}{4}$
$\frac{13}{16}$	$18\frac{7}{8}$	$6\frac{15}{32}$	$6\frac{7}{8}$	$4\frac{1}{8}$	4	$2\frac{1}{8}$	$3\frac{9}{16}$	11	$6\frac{7}{8}$
$\frac{7}{8}$	19	$6\frac{9}{16}$	$6\frac{7}{8}$	$4\frac{1}{8}$	4	$2\frac{1}{8}$	$3\frac{5}{8}$	11	7

SAFE LOADS IN TONS OF 2,000 LBS.
Z-BAR COLUMNS
SQUARE ENDS

Allowed stresses per square inch; safety factor 4: 12,000 lbs. for lengths of 90 radii or under; $17{,}100-57\frac{l}{r}$ for lengths over 90 radii

14 IN. Z-BAR COLUMNS

Section: 4 Z-Bars 6 1/8 × 1 1/16 in. 1 Web Plate 8 × 1 1/16 in. 2 Side Plates 14 in. w

Length of Column in Feet	14x3/8 Plates = 166.6 lbs. = 49.0 sq. in. r (min.) = 3.80	14x7/16 Plates = 172.6 lbs. = 50.8 sq. in. r (min.) = 3.81	14x1/2 Plates = 178.5 lbs. = 52.5 sq. in. r (min.) = 3.82	14x9/16 Plates = 184.5 lbs. = 54.3 sq. in. r (min.) = 3.82	14x5/8 Plates = 190.4 lbs. = 56.0 sq. in. r (min.) = 3.83	14x11/16 Plates = 196.4 lbs. = 57.8 sq. in. r (min.) = 3.84	14x3/4 Plates = 202.3 lbs. = 59.5 sq. in. r (min.) = 3.85	14x13/16 Plates = 208.4 lbs. = 61.3 sq. in. r (min.) = 3.85
28 and under	294.0	304.5	315.0	325.5	336.0	346.5	357.0	367.5
30	286.6	297.2	307.7	318.3	328.9	339.5	350.0	360.4
32	277.8	288.1	298.3	308.6	318.9	329.2	339.4	349.5
34	269.0	278.9	288.9	298.9	308.9	318.9	328.8	338.6
36	260.1	269.8	279.5	289.2	298.9	308.6	318.2	327.7
38	251.3	260.7	270.1	279.5	289.0	298.3	307.6	316.8
40	242.5	251.6	260.7	269.7	278.9	288.0	297.0	306.0
42	233.7	242.5	251.3	260.1	269.0	277.8	286.4	295.1
44	224.9	233.3	241.9	250.4	258.9	267.4	275.8	284.2
46	216.0	224.3	232.4	240.7	249.0	257.2	265.2	273.3
48	207.2	215.1	223.0	230.9	238.9	246.9	254.6	262.4
50	198.4	206.0	213.6	221.3	229.0	236.5	244.0	251.5

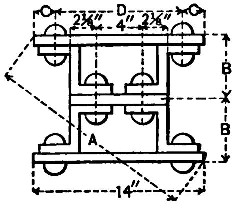
14 IN. Z-BAR COLUMNS

Section: 4 Z-Bars 6 × 3/4 in. 1 Web Plate 8 × 3/4 in. 2 Side Plates 14 in. wide

Length of Column in Feet	14x3/8 Plates = 173.4 lbs. = 51.0 sq. in. r (min.) = 3.75	14x7/16 Plates = 179.4 lbs. = 52.8 sq. in. r (min.) = 3.76	14x1/2 Plates = 185.3 lbs. = 54.5 sq. in. r (min.) = 3.77	14x9/16 Plates = 191.4 lbs. = 56.3 sq. in. r (min.) = 3.78	14x5/8 Plates = 197.2 lbs. = 58.0 sq. in. r (min.) = 3.79	14x11/16 Plates = 203.2 lbs. = 59.8 sq. in. r (min.) = 3.80	14x3/4 Plates = 209.1 lbs. = 61.5 sq. in. r (min.) = 3.80	14x13/16 Plates = 215.1 lbs. = 63.3 sq. in. r (min.) = 3.81
28 and under	306.0	316.5	327.0	337.5	348.0	358.5	369.0	379.5
30	296.7	307.2	317.8	328.3	338.9	349.4	359.9	370.5
32	287.4	297.6	307.9	318.2	328.4	338.7	348.9	359.1
34	278.1	288.0	298.0	308.0	318.0	327.9	337.8	347.8
36	268.8	278.4	288.2	297.9	307.4	317.2	326.8	336.4
38	259.5	268.8	278.3	287.7	297.0	306.4	315.7	325.1
40	250.2	259.3	268.4	277.5	286.5	295.6	304.7	313.7
42	240.9	249.7	258.5	267.3	276.1	284.8	293.6	302.4
44	231.6	240.1	248.6	257.1	265.6	274.1	282.5	291.0
46	222.4	230.5	238.7	246.9	255.1	263.4	271.5	279.7
48	213.0	220.9	228.8	236.8	244.7	252.6	260.4	268.3
50	203.7	211.3	219.0	226.6	234.2	241.8	249.4	257.0

To the above weights of column shafts add the weight of r

Z-BAR COLUMN DIMENSIONS



14 IN. COLUMNS

4 Z-Bars 6⅛ × $\frac{11}{16}$ in. 1 Web Plate 8 × $\frac{11}{16}$ in. 2 Side Plates 14 in. wide

Diameter of Bolt or Rivet, ⅞ in.

Thickness of Side Plates	A	B	C	D
⅜	$19\frac{9}{16}$	$6\frac{27}{32}$	1½	11
$\frac{7}{16}$	$19\frac{11}{16}$	$6\frac{29}{32}$	1½	11
½	19¾	$6\frac{31}{32}$	1½	11
$\frac{9}{16}$	19⅞	$7\frac{1}{32}$	1½	11
⅝	$19\frac{15}{16}$	$7\frac{3}{32}$	1½	11
$\frac{11}{16}$	$20\frac{1}{16}$	$7\frac{5}{32}$	1½	11
¾	20⅛	$7\frac{7}{32}$	1½	11
$\frac{13}{16}$	20¼	$7\frac{9}{32}$	1½	11
⅞	$20\frac{5}{16}$	$7\frac{11}{32}$	1½	11

14 IN. COLUMNS

4 Z-Bars 6 × ¾ in. 1 Web Plate 8 × ¾ in. 2 Side Plates 14 in. wide

Diameter of Bolt or Rivet, ⅞ in.

Thickness of Side Plates	A	B	C	D
⅜	$19\frac{7}{16}$	6¾	1½	11
$\frac{7}{16}$	19½	$6\frac{13}{16}$	1½	11
½	19⅝	6⅞	1½	11
$\frac{9}{16}$	19¾	$6\frac{15}{16}$	1½	11
⅝	$19\frac{13}{16}$	7	1½	11
$\frac{11}{16}$	19⅞	$7\frac{1}{16}$	1½	11
¾	20	7⅛	1½	11
$\frac{13}{16}$	$20\frac{1}{16}$	$7\frac{3}{16}$	1½	11
⅞	20⅛	7¼	1½	11

SAFE LOADS IN TONS OF 2,000 LBS.
Z-BAR COLUMNS
SQUARE ENDS

Allowed stresses per square inch; safety factor 4 $\left\{ \begin{array}{l} \text{12,000 lbs. for lengths of 90 radii or under} \\ 17{,}100\text{-}57\frac{l}{r} \text{ for lengths over 90 radii} \end{array} \right.$

14 IN. Z-BAR COLUMNS

Section: 4 Z-Bars $6\frac{1}{16} \times \frac{13}{16}$ in. 1 Web Plate $8 \times \frac{13}{16}$ in. 2 Side Plates 14 in. w…

Length of Column in Feet	14x3/8 Plates=185.6 lbs.=54.6 sq. in. r (min.)=3.73	14x7/16 Plates=191.5 lbs.=56.3 sq. in. r (min.)=3.74	14x1/2 Plates=197.5 lbs.=58.1 sq. in. r (min.)=3.75	14x9/16 Plates=203.4 lbs.=59.8 sq. in. r (min.)=3.76	14x5/8 Plates=209.4 lbs.=61.6 sq. in. r (min.)=3.77	14x11/16 Plates=215.3 lbs.=63.3 sq. in. r (min.)=3.78	14x3/4 Plates=221.3 lbs.=65.1 sq. in. r (min.)=3.78	14x13/16 Plates=227.2 lbs.=66.8 sq. in. r (min.)=3.79
26 and under	327.5	338.0	348.5	359.0	369.5	380.0	390.5	401.0
28	326.7	337.5	348.5	359.0	369.5	380.0	390.5	401.0
30	316.7	327.2	337.7	348.3	358.9	369.5	380.0	390.6
32	306.6	318.0	327.2	337.4	347.7	358.0	368.2	378.5
34	296.6	306.6	316.6	326.5	336.5	346.5	356.4	366.4
36	286.7	296.4	306.0	315.7	325.3	335.0	344.7	354.3
38	276.7	286.0	295.4	304.8	314.2	323.6	332.9	342.3
40	266.6	275.7	284.8	293.9	303.0	312.1	321.2	330.3
42	256.6	265.5	274.3	283.0	291.8	300.6	309.4	318.2
44	246.6	255.2	263.6	272.2	280.6	289.2	297.6	306.1
46	236.6	244.9	253.0	261.3	269.5	277.7	285.8	294.0
48	226.7	234.6	242.5	250.4	258.3	266.2	274.1	282.0
50	216.6	224.3	231.9	239.5	247.1	254.8	262.3	269.9

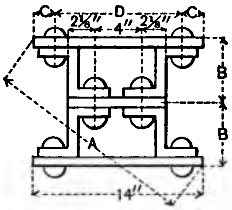
14 IN. Z-BAR COLUMNS

Section: 4 Z-Bars $6\frac{1}{8} \times \frac{7}{8}$ in. 1 Web Plate $8 \times \frac{7}{8}$ in. 2 Side Plates 14 in. w…

Length of Column in Feet	14x3/8 Plates=197.8 lbs.=58.2 sq. in. r (min.)=3.71	14x7/16 Plates=203.8 lbs.=59.9 sq. in. r (min.)=3.72	14x1/2 Plates=209.7 lbs.=61.7 sq. in. r (min.)=3.73	14x9/16 Plates=215.7 lbs.=63.4 sq. in. r (min.)=3.74	14x5/8 Plates=221.6 lbs.=65.2 sq. in. r (min.)=3.75	14x11/16 Plates=227.6 lbs.=66.9 sq. in. r (min.)=3.76	14x3/4 Plates=233.5 lbs.=68.7 sq. in. r (min.)=3.77	14x13/16 Plates=239.5 lbs.=70.4 sq. in. r (min.)=3.77
26 and under	349.1	359.6	370.1	380.6	391.1	401.6	412.1	422.6
28	347.4	358.3	369.1	380.0	390.9	401.6	412.1	422.6
30	336.7	347.2	357.9	368.4	378.9	389.5	400.1	410.7
32	326.0	336.3	346.6	356.8	367.1	377.3	387.6	397.9
34	315.3	325.2	335.2	345.2	355.1	365.2	375.2	385.1
36	304.5	314.2	324.0	333.6	343.3	353.0	362.7	372.4
38	293.8	303.2	312.6	322.0	331.4	340.8	350.2	359.6
40	283.1	292.2	301.3	310.4	319.5	328.6	337.7	346.8
42	272.3	281.2	290.0	298.8	307.6	316.4	325.2	334.0
44	261.6	270.2	278.7	287.2	295.7	304.2	312.7	321.2
46	250.9	259.1	267.4	275.6	283.8	292.1	300.3	308.5
48	240.2	248.1	256.1	264.0	272.0	279.8	287.8	295.7
50	229.5	237.1	244.8	252.4	260.0	267.8	275.3	[illegible]

To the above weights of column shafts add the weight of r…

Z-BAR COLUMN DIMENSIONS



14 IN. COLUMNS

4 Z-Bars $6\frac{1}{16} \times \frac{13}{16}$ in.   1 Web Plate $8 \times \frac{13}{16}$ in.   2 Side Plates 14 in. wide

Diameter of Bolt or Rivet, ⅞ in.

Thickness of Side Plates	A	B	C	D
⅜	$19\frac{9}{16}$	$6\frac{27}{32}$	1½	11
$\frac{7}{16}$	19⅝	$6\frac{29}{32}$	1½	11
½	19¾	$6\frac{31}{32}$	1½	11
$\frac{9}{16}$	19⅞	$7\frac{1}{32}$	1½	11
⅝	$19\frac{15}{16}$	$7\frac{3}{32}$	1½	11
$\frac{11}{16}$	$20\frac{1}{16}$	$7\frac{5}{32}$	1½	11
¾	20⅛	$7\frac{7}{32}$	1½	11
$\frac{13}{16}$	$20\frac{3}{16}$	$7\frac{9}{32}$	1½	11
⅞	20¼	$7\frac{11}{32}$	1½	11

14 IN. COLUMNS

4 Z-Bars 6⅛ × ⅞ in.   1 Web Plate 8 × ⅞ in.   2 Side Plates 14 in. wide

Diameter of Bolt or Rivet, ⅞ in.

Thickness of Side Plates	A	B	C	D
⅜	19¾	$6\frac{15}{16}$	1½	11
$\frac{7}{16}$	$19\frac{13}{16}$	7	1½	11
½	19⅞	$7\frac{1}{16}$	1½	11
$\frac{9}{16}$	20	7⅛	1½	11
⅝	$20\frac{1}{16}$	$7\frac{3}{16}$	1½	11
$\frac{11}{16}$	20⅛	7¼	1½	11
¾	20¼	$7\frac{5}{16}$	1½	11
$\frac{13}{16}$	$20\frac{5}{16}$	7⅜	1½	11
⅞	$20\frac{7}{16}$	$7\frac{7}{16}$	1½	11

SAFE LOADS IN TONS OF 2,000 LBS.
CONSTANT DIMENSION Z-BAR COLUMNS—SQUARE

Allowed stresses per square inch; safety factor 4: 12,000 lbs. for lengths of 90 radii or unde[r]; $17{,}100-57\frac{l}{r}$ for lengths over 90 radii

Section: 4 Z-Bars 4 in. deep with Tie Plates

Length of Column in Feet	4Z's 4"x3 1/16"x1/4" 9.64 sq. in. 32.8 lbs. r min. 4.0952	4Z's 4 1/16"x3 1/8"x5/16" 12.12 sq. in. 41.2 lbs. r min. 4.0714	4Z's 4 1/8"x3 3/16"x3/8" 14.64 sq. in. 49.6 lbs. r min. 4.0478	4Z's 4"x3 1/16"x7/16" 16.20 sq. in. 55.2 lbs. r min. 3.9949	4Z's 4 1/16"x3 1/8"x1/2" 18.64 sq. in. 63.2 lbs. r min. 3.9712	4Z's 4 1/8"x3 3/16"x9/16" 21.08 sq. in. 71.6 lbs. r min. 3.9479	4Z's 4"x3 1/16"x5/8" 22.20 sq. in. 75.6 lbs. r min. 3.8949	4Z's 4 1/16"x3 1/8"x11/16" 24.56 sq. in. 83.6 lbs. r min. 3.8715
28 and under	......	......	......	97.2	111.8	126.5	133.2	147.
30	57.8	72.7	87.8	96.9	111.2	125.5	131.3	144.
32	56.7	71.1	85.6	94.1	108.0	121.8	127.4	140.
34	55.0	69.0	83.1	91.4	104.8	118.2	123.5	136.
36	53.4	67.0	80.6	88.6	101.6	114.5	119.6	131.
38	51.8	64.9	78.2	85.8	98.4	110.8	115.7	127.
40	50.2	62.9	75.7	83.0	95.2	107.2	111.8	123.

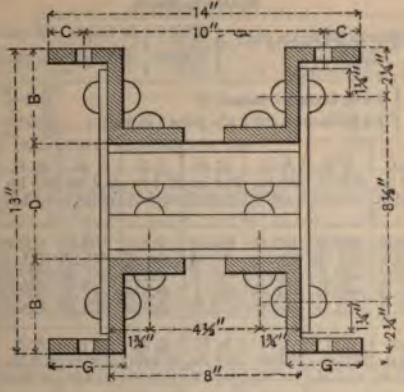
Section: 4 Z-Bars 4 in. deep 4 × 3 1/16 × 5/8 in. with Web Plates

Length of Column in Feet	2 Pl's 8"x3/8" 28.20 sq. in. 96 lbs. r min. 3.6163	2 Pl's 8"x7/16" 29.20 sq. in. 99.4 lbs. r min. 3.5794	2 Pl's 8"x1/2" 30.20 sq. in. 103.8 lbs. r min. 3.5447	2 Pl's 8"x9/16" 31.20 sq. in. 106.2 lbs. r min. 3.5118	2 Pl's 8"x5/8" 32.20 sq. in. 109.6 lbs. r min. 3.4807	2 Pl's 8"x3/4" 34.2 sq. in. 116.3 lbs. r min. 3.4233	2 Pl's 8"x7/8" 36.2 sq. in. 123.1 lbs. r min. 3.3714	2 Pl's 8"x1" 38.2 sq. in. 129.9 lbs. r min. 3.3242
26 and under	169.2	175.2	181.2	187.2	193.2	205.2	217.2	229.
28	166.4	171.5	176.6	181.7	186.7	196.7	206.7	216.
30	161.1	166.0	170.8	175.6	180.4	189.9	199.3	208.
32	155.8	160.4	165.0	169.5	174.1	183.1	192.0	200.
34	150.4	154.8	159.1	163.5	167.7	176.2	184.7	193.
36	145.1	149.2	153.3	157.4	161.4	169.4	177.3	185.
38	139.8	143.6	147.5	151.3	155.1	162.6	170.0	177.
40	134.4	138.1	141.7	145.2	148.8	155.7	162.6	169.

Section: 4 Z-Bars 4 in. deep 4 1/8 × 3 3/16 × 3/4 in. with Web Plates

Length of Column in Feet	2 Pl's 8"x7/8" 41 sq. in. 139.4 lbs. r min 3.4017	2 Pl's 8"x1" 43 sq. in. 146.2 lbs. r min. 3.3587	2 Pl's 8"x1 1/8" 45 sq. in. 153 lbs. r min. 3.3192	2 Pl's 8"x1 1/4" 47 sq. in. 159.8 lbs. r min. 3.2825	2 Pl's 8"x1 3/8" 49 sq. in. 166.6 lbs. r min. 3.2485	2 Pl's 8"x1 1/2" 51 sq. in. 173.4 lbs. r min. 3.2169	2 Pl's 8"x1 5/8" 53 sq. in. 180.2 lbs. r min. 3.1873	2 Pl's 8"x1 3/4" 55 sq. in. 187 lbs. r min. 3.1597
22 and under	......	......	......	......	......	......	318.0	330.
24	246.0	258.0	270.0	282.0	294.0	306.0	316.7	327.
26	243.4	253.8	264.2	274.5	284.8	295.1	305.3	315.
28	235.1	245.1	254.9	264.7	274.5	284.2	293.9	303.
30	226.9	236.3	245.7	254.9	264.2	273.4	282.6	291.
32	218.7	227.5	236.4	245.2	253.9	262.6	271.2	279.
34	210.4	218.8	227.1	235.4	243.6	251.7	259.8	267.
36	202.2	210.0	217.8	225.6	233.2	240.9	248.4	255.
38	193.9	201.3	208.6	215.8	222.9	230.0	237.1	244.
40	185.7	192.5	199.3	206.0	212.6	219.2	225.7	232

NSTANT DIMENSION Z-BAR COLUMNS



stant dimensions are given on the sketch above for all columns. iable dimensions see below. All rivets ¾" dia. Open holes for ts or bolts.

b tie plates 9" x 5/16" x 0'—8" } for all columns less than ⅝" metal.
nge tie plates 9" x 5/16" x 0'—11" }

all columns ⅝" metal and over, tie plates are ⅜" thick.

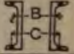
tie plates spaced about 3' 0" center to center.

es of Z Bars	A	B	C	D	G
3 1/16" x ¼" ...	13⅝"	4"	1 13/16"	5"	3 1/16"
3⅛" x 5/16" ...	13⅝"	4 1/16"	1 13/16"	4⅞"	3⅛"
3 3/16" x ⅜" ...	13⅝"	4⅛"	1 13/16"	4¾"	3 3/16"
3 1/16" x 7/16" ...	13¼"	4"	1⅝"	5"	3 1/16"
3⅛" x ½" ...	13¼"	4 1/16"	1⅝"	4⅞"	3⅛"
3 3/16" x 9/16" ...	13¼"	4⅛"	1⅝"	4¾"	3 3/16"
3 1/16" x ⅝" ...	12⅞"	4"	1 7/16"	5"	3 1/16"
3⅛" x 11/16" ...	12⅞"	4 1/16"	1 7/16"	4⅞"	3⅛"
3 3/16" x ¾" ...	12⅞"	4⅛"	1 7/16"	4¾"	3 3/16"

SAFE LOADS IN TONS OF 2,000 LBS.
6 IN. CHANNEL COLUMNS
SQUARE ENDS

Allowed stresses per square inch; safety factor 4 — 12,000 lbs. for lengths of 90 radii or under; $17{,}100-57\frac{1}{r}$ for lengths over 90 radii

Sections: 2-6 in. Channels—latticed, or 2-6 in. Channels and 2 side plates 8 in. wide


B=3⅜ i
C=5¾ i

Weight of Channels	Length of Col. in feet								
		Lat. 16.0 lbs. r=2.33	¼ Pl. 29.6 lbs. r=2.32	5/16 Pl. 33.0 lbs. r=2.32	⅜ Pl. 36.4 lbs. r=2.32	7/16 Pl. 39.8 lbs. r=2.32	½ Pl. 43.2 lbs. r=2.32	9/16 Pl. 46.6 lbs. r=2.32	⅝ Pl. 50.0 lbs. r=2.32
8 lbs.	16	28.6	52.6	58.6	64.6	70.6	76.6	82.6	88.6
	18	28.1	51.7	57.5	63.4	69.3	75.2	81.1	87.0
	20	26.7	49.1	54.7	60.3	65.8	71.4	77.0	82.6
	22	25.3	46.5	51.8	57.1	62.4	67.7	73.0	78.2
	24	23.9	43.9	48.9	53.9	58.9	63.9	68.9	73.9
		Lat. 21.0 lbs. r=2.20	¼ Pl. 34.6 lbs. r=2.24	5/16 Pl. 38.0 lbs. r=2.25	⅜ Pl. 41.4 lbs. r=2.25	7/16 Pl. 44.8 lbs. r=2.26	½ Pl. 48.2 lbs. r=2.26	9/16 Pl. 51.6 lbs. r=2.27	⅝ Pl. 55.0 lbs. r=2.27
10.5 lbs.	16	37.1	61.1	67.1	73.1	79.1	85.1	91.1	97.1
	18	35.5	59.1	65.0	70.9	76.8	82.7	88.5	94.4
	20	33.6	56.0	61.6	67.2	72.8	78.4	84.0	89.5
	22	31.7	52.9	58.2	63.5	68.8	74.1	79.4	84.7
		Lat. 26.0 lbs. r=2.09	5/16 Pl. 4.30 lbs. r=2.18	⅜ Pl. 46.4 lbs. r=2.19	7/16 Pl. 49.8 lbs. r=2.20	½ Pl. 53.2 lbs. r=2.21	9/16 Pl. 56.6 lbs. r=2.21	⅝ Pl. 60.0 lbs. r=2.22	11/16 Pl. 63.4 lbs. r=2.22
13 lbs.	14	45.8	......	......	......	......	......	......	......
	16	45.3	75.8	81.8	87.8	93.8	99.8	105.8	111.8
	18	42.8	72.4	78.3	84.2	90.1	96.0	101.9	107.8
	20	40.3	68.4	74.1	79.7	85.2	90.8	96.4	102.0
	22	37.8	64.5	69.8	75.1	80.4	85.7	91.0	96.3
		Lat. 31.0 lbs. r=2.00	5/16 Pl. 48.0 lbs. r=2.12	⅜ Pl. 51.4 lbs r=2.13	7/16 Pl. 54.8 lbs. r=2.14	½ Pl. 58.2 lbs. r=2.15	9/16 Pl. 61.6 lbs. r=2.16	⅝ Pl. 65.0 lbs. r=2.17	11/16 Pl. 68.4 lbs. r=2.18
15.5 lbs.	14	54.7	84.7	90.7	......	......	......	......	......
	16	53.0	84.2	90.4	96.7	102.7	108.7	114.7	120.7
	18	49.9	79.7	85.6	91.5	97.4	103.3	109.2	115.1
	20	46.8	75.1	80.7	86.4	92.0	97.6	103.2	108.8
	22	......	70.5	75.9	81.2	86.5	91.8	97.1	102.5

To the above weights of column shafts add the weight of rivets and lattice b
The safe loads given in this and the following tables on channel columns
value from $\frac{1}{r}=90$ to about $\frac{1}{r}=125$.

The size and spacing of lattice bars should be proportioned to the sectio *posing the column.* They should not be less than 1½ x 5-16 in. for 6-in. cl *1¾ x 5-16 in. for* 7 and 8-in. channels; 2 x 5-16 in. for 9 and 10-in. channels; 2 x *12-in. channels.*

SAFE LOADS IN TONS OF 2,000 LBS.
7 IN. CHANNEL COLUMNS
SQUARE ENDS

Allowed stresses per square inch; safety factor 4 { 12,000 lbs. for lengths of 90 radii or under; $17{,}100-57\frac{l}{r}$ for lengths over 90 radii

ctions: { 2-7 in. Channels—latticed, or; 2-7 in. Channels and 2 side plates 9 in. wide

B = 4⅝ in.
C = 6¾ in.

	Length of Col. in ft.									
		Lat. 19.5 lbs. r=2.72	¼ Pl. 34.8 lbs. r=2.67	5/16 Pl. 38.6 lbs. r=2.67	⅜ Pl. 42.5 lbs. r=2.66	7/16 Pl. 46.3 lbs. r=2.66	½ Pl. 50.1 lbs. r=2.65	9/16 Pl. 53.9 lbs. r=2.65	⅝ Pl. 57.8 lbs. r=2.64	11/16 Pl. 61.6 lbs. r=2.64
	18	......	......	......	74.7	81.5	88.2	94.9	101.7	108.5
	20	34.2	61.2	67.9	74.4	81.1	87.8	94.4	101.1	107.8
	22	32.8	58.5	65.0	71.2	77.6	84.0	90.3	96.7	103.1
	24	31.4	55.9	62.0	68.0	74.1	80.2	86.2	92.3	98.4
	26	30.1	53.3	59.1	64.8	70.6	76.4	82.1	87.9	93.7
	28	28.7	......	......	......	......	......	......	......	......
12.25 lbs.		Lat. 24.5 lbs. r=2.59	¼ Pl. 39.8 lbs. r=2.60	5/16 Pl. 43.6 lbs. r=2.60	⅜ Pl. 47.5 lbs. r=2.60	7/16 Pl. 51.3 lbs. r=2.60	½ Pl. 55.1 lbs. r=2.60	9/16 Pl. 58.9 lbs. r=2.60	⅝ Pl. 62.8 lbs. r=2.60	11/16 Pl. 66.6 lbs. r=2.60
	18	43.2	70.2	76.9	83.7	90.5	97.2	103.9	110.7	117.5
	20	42.5	69.3	75.9	82.6	89.3	95.9	102.6	109.2	115.9
	22	40.6	66.2	72.6	79.0	85.3	91.7	98.0	104.4	110.8
	24	38.7	63.2	69.2	75.3	81.4	87.4	93.5	99.5	105.6
	26	36.8	60.1	65.8	71.6	77.4	83.2	88.9	94.7	100.5
14.75 lbs.		Lat. 29.5 lbs. r=2.50	¼ Pl. 44.8 lbs. r=2.54	5/16 Pl. 48.6 lbs. r=2.55	⅜ Pl. 52.5. lbs. r=2.55	7/16 Pl. 56.3 lbs. r=2.55	½ Pl. 60.1 lbs. r=2.56	9/16 Pl. 63.9 lbs. r=2.56	⅝ Pl. 67.8 lbs. r=2.56	11/16 Pl. 71.6 lbs. r=2.56
	18	52.1	79.1	85.8	92.6	99.4	106.1	112.8	119.6	126.4
	20	50.5	77.2	83.8	90.5	97.2	103.8	110.5	117.2	123.9
	22	48.1	73.7	80.0	86.4	92.8	99.1	105.5	111.8	118.2
	24	45.7	70.1	76.2	82.3	88.3	94.4	100.4	106.5	112.6
	26	43.3	66.6	72.3	78.1	83.9	89.7	95.4	101.2	107.0
17.25 lbs.		Lat. 34.5 lbs. r=2.43	5/16 Pl. 53.6 lbs. r=2.49	⅜ Pl. 57.5 lbs. r=2.50	7/16 Pl. 61.3 lbs. r=2.50	½ Pl. 65.1 lbs. r=2.51	9/16 Pl. 68.9 lbs. r=2.51	⅝ Pl. 72.8 lbs. r=2.52	11/16 Pl. 76.6 lbs. r=2.52	¾ Pl. 80.4 lbs. r=2.53
	18	60.8	94.6	101.3	108.1	114.8	121.6	128.3	135.1	141.8
	20	58.1	91.4	98.2	104.8	111.5	118.1	124.8	131.5	138.1
	22	55.3	87.1	93.5	99.9	106.3	112.6	119.0	125.4	131.7
	24	52.4	82.8	88.9	95.0	101.1	107.1	113.2	119.3	125.3
	26	......	78.5	84.3	90.1	95.8	101.6	107.4	113.2	118.9
19.75 lbs.		Lat. 39.5 lbs. r=2.35	5/16 Pl. 58.6 lbs. r=2.44	⅜ Pl. 62.5 lbs. r=2.45	7/16 Pl. 66.3 lbs. r=2.45	½ Pl. 70.1 lbs. r=2.46	9/16 Pl. 73.9 lbs. r=2.47	⅝ Pl. 77.8 lbs. r=2.48	11/16 Pl. 81.6 lbs. r=2.48	¾ Pl. 85.4 lbs. r=2.49
	16	69.7	......	......	......	......	......	......	......	......
	18	68.9	103.4	110.2	117.0	123.7	130.4	137.2	144.0	150.7
	20	65.5	99.0	105.7	112.4	119.0	125.7	132.4	139.1	145.7
	22	62.2	94.2	100.6	107.0	113.3	119.6	126.1	132.4	138.8
	24	58.8	89.3	95.4	101.5	107.6	113.6	119.7	125.8	131.9

To the above weights of column shafts add the weight of rivets and lattice bars.

SAFE LOADS IN TONS OF 2,000 LB

8 IN. CHANNEL COLUMNS

SQUARE ENDS

Allowed stresses per square inch; safety factor 4 { 12,000 lbs. for lengths of 90 radii or
$17,100-57\frac{l}{r}$ for lengths over 90 radii

Sections: { 2-8 in. Channels—latticed, or
2-8 in. Channels and 2 side plates 10 in. wide

B C

Weight of Channels	Length of Col. in ft.	Lat. 22.5 lbs. r=3.11	1/4 Pl. 39.5 lbs. r=3.03	5/16 Pl. 43.7 lbs. r=3.02	3/8 Pl. 48.0 lbs. r=3.01	7/16 Pl. 52.3 lbs. r=3.00	1/2 Pl. 56.5 lbs. r=2.99	9/16 Pl. 60.8 lbs. r=2.98	65 r
11.25 lbs.	22	40.2	70.2	77.7	85.2	92.7	100.2	107.7	1
	24	39.6	68.4	75.5	82.7	89.8	97.0	104.1	1
	26	38.1	65.7	72.6	79.4	86.3	93.1	100.1	1
	28	36.6	63.1	69.7	76.2	82.8	89.3	95.9	1
	30	35.2	60.5	66.7	73.0	79.2	85.5	91.8	
	32	33.7	......	......	......	......	......	......	
		Lat. 27.5 lbs. r=2.98	5/16 Pl. 48.7 lbs. r=2.97	3/8 Pl. 53.0 lbs. r=2.96	7/16 Pl. 57.3 lbs. r=2.96	1/2 Pl. 61.5 lbs. r=2.95	9/16 Pl. 65.8 lbs. r=2.95	5/8 Pl. 70.0 lbs. r=2.95	7 r
13.75 lbs.	22	48.5	86.0	93.5	101.0	108.5	116.0	123.5	1
	24	46.8	82.9	90.1	97.2	104.3	111.5	118.6	1
	26	45.0	79.6	86.5	93.3	100.1	107.0	113.8	1
	28	43.1	76.3	82.9	89.4	96.0	102.5	109.0	1
	30	41.3	73.0	79.3	85.5	91.8	98.0	104.3	1
		Lat. 32.5 lbs. r=2.89	3/8 Pl. 58.0 lbs. r=2.92	7/16 Pl. 62.3 lbs. r=2.91	1/2 Pl. 66.5. lbs. r=2.91	9/16 Pl. 70.8 lbs. r=2.91	5/8 Pl. 75.0 lbs. r=2.91	11/16 Pl. 79.2 lbs. r=2.91	8 r
16.25 lbs.	20	57.4	102.4	109.9	117.4	124.9	132.4	139.9	1
	22	56.8	101.9	109.3	116.7	124.2	131.6	139.0	1
	24	54.6	97.9	105.0	112.1	119.3	126.4	133.5	1
	26	52.3	93.9	100.7	107.5	114.4	121.2	128.0	1
	28	50.1	89.9	96.4	102.9	109.5	116.0	122.6	1
	30	47.8	85.9	92.1	98.3	104.6	110.8	117.1	1
		Lat. 37.5 lbs. r=2.82	7/16 Pl. 67.3 lbs. r=2.87	1/2 Pl. 71.5 lbs. r=2.87	9/16 Pl. 75.8 lbs. r=2.87	5/8 Pl. 80.0 lbs. r=2.87	11/16 Pl. 84.2 lbs. r=2.87	3/4 Pl. 88.5 lbs. r=2.88	9 r
18.75 lbs.	20	66.1	118.6	126.1	133.6	141.1	148.6	156.1	1
	22	64.8	117.3	124.7	132.1	139.5	147.0	154.4	1
	24	62.1	112.6	119.7	126.8	133.9	141.1	148.2	1
	26	59.5	107.8	114.7	121.5	128.3	135.2	142.0	1
	28	56.8	103.1	109.7	116.2	122.8	129.3	135.8	1
	30	......	98.4	104.7	110.9	117.2	123.4	129.6	1
		Lat. 42.5 lbs. r=2.77	1/2 Pl. 76.5 lbs. r=2.33	9/16 Pl. 80.8 lbs. r=2.84	5/8 Pl. 35.0 lbs. r=2.84	11/16 Pl. 89.2 lbs. r=2.84	3/4 Pl. 93.5 lbs. r=2.84	13/16 Pl. 97.8 lbs. r=2.84	10 r
21.25 lbs.	20	75.0	135.0	142.5	150.0	157.5	165.0	172.5	1
	22	72.9	132.6	140.0	147.5	154.9	162.3	169.8	1
	24	69.8	127.2	134.3	141.5	148.6	155.7	162.9	1
	26	66.7	121.7	128.6	135.4	142.3	149.1	155.9	1
	28	63.7	116.3	122.9	129.4	136.0	142.5	149.0	1

To the above weights of column shafts add the weight of rivets and

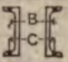
SAFE LOADS IN TONS OF 2,000 LBS.

9 IN. CHANNEL COLUMNS

SQUARE ENDS

Allowed stresses per square inch; safety factor 4 — 12,000 lbs. for lengths of 90 radii or under; $17{,}100-57\frac{l}{r}$ for lengths over 90 radii

Sections: 2-9 in. Channels—latticed, or 2-9 in. Channels and 2 side plates 11 in. wide



B=6¼ in.
C=8½ in.

Weight of Channels	Length of Col. in feet	Lat. 26.5 lbs. r=3.49	¼ Pl. 45.2 lbs. r=3.40	$\frac{5}{16}$ Pl. 49.9 lbs. r=3.38	⅜ Pl. 54.6 lbs. r=3.36	$\frac{7}{16}$ Pl. 59.2 lbs. r=3.35	½ Pl. 63.9 lbs. r=3.33	$\frac{9}{16}$ Pl. 68.5 lbs. r=3.32	⅝ Pl. 73.3 lbs. r=3.31	$\frac{11}{16}$ Pl. 77.9 lbs. r=3.31
13.25 lbs.	24	......	79.7	88.0	96.2	104.4	112.7	121.0	129.2	137.4
	26	46.7	78.8	86.7	94.6	102.5	110.5	118.4	126.3	134.2
	28	45.2	76.1	83.8	91.4	99.0	106.6	114.3	121.9	129.5
	30	43.6	73.4	80.8	88.1	95.4	102.8	110.1	117.4	124.7
	32	42.1	70.8	77.8	84.9	91.9	98.9	106.0	113.0	120.0
	34	40.6	68.1	74.9	81.6	88.3	95.1	101.8	108.5	115.2
		Lat. 30.0 lbs. r=3.40	¼ Pl. 48.7 lbs. r=3.36	$\frac{5}{16}$ Pl. 53.4 lbs. r=3.34	⅜ Pl. 58.1 lbs. r=3.33	$\frac{7}{16}$ Pl. 62.7 lbs. r=3.32	½ Pl. 67.4 lbs. r=3.31	$\frac{9}{16}$ Pl. 72.0 lbs. r=3.30	⅝ Pl. 76.8 lbs r=3.29	$\frac{11}{16}$ Pl. 81.4 lbs. r=3.29
15 lbs.	24	52.9	85.9	94.2	102.4	110.6	118.9	127.2	135.4	143.6
	26	52.3	84.5	92.5	100.4	108.3	116.2	124.1	132.0	139.9
	28	50.6	81.6	89.3	96.9	104.5	112.1	119.7	127.4	135.0
	30	48.8	78.7	86.1	93.4	100.7	108.0	115.4	122.7	130.0
	32	47.0	75.8	82.8	89.9	96.9	103.9	111.0	118.0	125.0
	34	45.2	72.9	79.6	86.4	93.1	99.8	106.6	113.3	120.0
		Lat. 40.0 lbs. r=3.21	⅜ Pl. 68.1 lbs. r=3.25	$\frac{7}{16}$ Pl. 72.7 lbs. r=3.25	½ Pl. 77.4 lbs. r=3.24	$\frac{9}{16}$ Pl. 82.0 lbs. r=3.24	⅝ Pl. 86.8 lbs. r=3.23	$\frac{11}{16}$ Pl. 91.4 lbs. r=3.23	¾ Pl. 96.1 lbs. r=3.23	$\frac{13}{16}$ Pl. 100.8 lbs. r=3.23
20 lbs.	24	70.6	120.1	128.3	136.6	144.8	153.1	161.3	169.6	177.8
	26	68.0	116.3	124.2	132.1	140.1	148.0	155.8	163.8	171.7
	28	65.5	112.1	119.7	127.3	135.0	142.6	150.1	157.8	165.4
	30	63.0	107.9	115.2	122.5	129.9	137.2	144.5	151.8	159.2
	32	60.5	103.7	110.7	117.7	124.8	131.8	138.8	145.8	152.9
		Lat. 50.0 lbs. r=3.10	$\frac{9}{16}$ Pl. 92.0 lbs. r=3.17	⅝ Pl. 96.8 lbs r=3.17	$\frac{11}{16}$ Pl. 101.4 lbs. r=3.17	¾ Pl. 106.1 lbs. r=3.17	$\frac{13}{16}$ Pl. 110.8 lbs. r=3.17	⅞ Pl. 115.4 lbs. r=3.17	$\frac{15}{16}$ Pl. 120.1 lbs. r=3.17	1" Pl. 124.8 lbs r=3.17.
25 lbs.	22	88.2	162.5	170.7	178.9	187.2	195.5	203.7	211.9	220.2
	24	86.8	161.5	169.6	177.8	186.0	194.3	202.4	210.6	218.8
	26	83.5	155.6	163.5	171.4	179.3	187.2	195.1	203.0	210.9
	28	80.3	149.8	157.4	164.9	172.6	180.2	187.8	195.4	203.0
	30	77.0	143.9	151.2	158.5	165.9	173.2	180.5	187.8	195.1
	32	73.8	138.1	145.1	152.1	159.1	166.2	173.2	180.2	187.2

To the above weights of column shafts add the weight of rivets and lattice bars.

SAFE LOADS IN TONS OF 2,000 LBS.—10" CHANNEL COLUMNS—SQUA

Allowed stresses per square inch; safety factor 4: 12,000 lbs. for lengths of 90 radii or un; $17{,}100-57\frac{l}{r}$ for lengths over 90 radii

Sections: 2-10 in. Channels—latticed, or 2-10 in. Channels and 2 side plates 12 in. wide; B = 7; C = 9

Weight of Channels	Length of Col. in ft.	Lat. 30.0 lbs. r=3.87	5/16 Pl. 55.5 lbs. r=3.74	3/8 Pl. 60.6 lbs. r=3.72	7/16 Pl. 65.7 lbs. r=3.70	1/2 Pl. 70.8 lbs. r=3.68	9/16 Pl. 75.9 lbs. r=3.67	5/8 Pl. 81.0 lbs. r=3.65	11/16 Pl. 86.1 lbs r=3.64
15 lbs.	26	......	......	107.5	116.5	125.5	134.5	143.5	152.
	28	53.5	98.5	107.0	115.7	124.4	133.1	141.8	150.
	30	52.6	95.3	103.7	112.2	120.5	128.9	137.3	145.
	32	51.0	92.3	100.4	108.6	116.7	124.8	132.9	141.
	34	49.5	89.3	97.1	105.0	112.8	120.6	128.4	136.
	36	47.9	86.3	93.8	101.4	108.9	116.4	123.9	131.
	38	46.3	83.3	90.5	97.8	105.0	112.2	119.4	126.
	40	44.7	......	......	......	......	......	......	......
		Lat. 40.0 lbs. r=3.66	7/16 Pl. 75.7 lbs. r=3.64	1/2 Pl. 80.8 lbs. r=3.63	9/16 Pl. 85.9 lbs. r=3.62	5/8 Pl. 91.0 lbs. r=3.61	11/16 Pl. 96.1 lbs. r=3.60	3/4 Pl. 101.2 lbs. r=3.59	13/16 Pl. 106.3 lbs r=3.59
20 lbs.	26	70.6	133.6	142.6	151.6	160.6	169.6	178.6	187.
	28	69.8	131.7	140.4	149.1	157.8	166.4	175.1	183.
	30	67.6	127.5	135.9	144.3	152.7	161.1	169.5	177.
	32	65.4	123.3	131.4	139.5	147.6	155.7	163.8	171.
	34	63.2	119.1	126.9	134.7	142.5	150.3	158.1	165.
	36	61.0	114.9	122.4	129.9	137.5	145.0	152.5	160.
	38	58.8	......	......	......	......	......	......	......
		Lat. 50.0 lbs. r=3.52	9/16 Pl. 95.9 lbs. r=3.56	5/8 Pl. 101.0 lbs. r=3.55	11/16 Pl. 106.1 lbs. r=3.55	3/4 Pl. 111.2 lbs. r=3.55	13/16 Pl. 116.3 lbs. r=3.54	7/8 Pl. 121.4 lbs. r=3.54	15/16 Pl. 126.5 lbs r=3.54
25 lbs.	26	88.2	169.2	178.2	187.2	196.2	205.2	214.2	223.
	28	85.7	165.3	173.9	182.6	191.3	200.0	208.7	217.
	30	82.8	159.8	168.2	176.6	185.0	193.4	201.8	210.
	32	80.0	154.4	162.5	170.6	178.7	186.8	194.9	202.
	34	77.1	149.0	156.8	164.6	172.3	180.2	188.0	195.
	36	74.3	143.6	151.1	158.5	166.0	173.6	181.1	188.
		Lat. 60.0 lbs. r=3.42	11/16 Pl. 116.1 lbs. r=3.50	3/4 Pl. 121.2 lbs. r=3.50	13/16 Pl. 126.3 lbs. r=3.49	7/8 Pl. 131.4 lbs. r=3.49	15/16 Pl. 136.5 lbs. r=3.49	1" Pl. 141.6 lbs. r=3.49	1 1/8 Pl. 151.8 lbs r=3.49
30 lbs.	24	105.8	......	......	......	......	......	......	......
	26	105.0	204.8	213.8	222.8	231.8	240.8	249.8	267.
	28	101.4	198.4	207.1	215.8	224.5	233.2	241.8	259.
	30	97.9	191.8	200.2	208.5	216.9	225.3	233.7	250.
	32	94.4	185.1	193.2	201.3	209.3	217.4	225.5	241.
	34	90.9	178.4	186.2	194.0	201.8	209.6	217.4	232.
	36	......	171.7	179.2	186.7	194.2	201.7	209.2	224.
		Lat. 70.0 lbs. r=3.35	13/16 Pl. 136.3 lbs. r=3.45	7/8 Pl. 141.4 lbs. r=3.45	15/16 Pl. 146.5 lbs. r=3.45	1" Pl. 151.6 lbs. r=3.45	1 1/8 Pl. 161.8 lbs. r=3.45	1 1/4 Pl. 172.0 lbs. r=3.45	1 3/8 Pl. 182.2 lbs r=3.45
35 lbs.	24	123.5	240.5	249.5	258.5	267.5	285.5	303.5	321.
	26	121.3	239.3	248.2	257.2	266.2	284.1	302.1	320.
	28	117.1	231.3	240.0	248.7	257.3	274.7	292.1	309.
	30	112.9	223.3	231.7	240.1	248.5	265.2	282.0	298.
	32	108.7	215.4	223.5	231.6	239.6	255.8	272.0	288.
	34	104.5	207.4	215.2	223.0	230.8	246.3	262.0	277.
	36	......	199.5	207.0	214.5	222.0	236.9	251.9	266.

To the above weights of column shafts add the weight of rivets and lat

LOADS IN TONS OF 2,000 LBS.—12" CHANNEL COLUMNS—SQUARE ENDS

Allowed stresses per square inch; safety factor 4 { 12,000 lbs. for lengths of 90 radii or under; $17{,}000-57\frac{l}{r}$ for lengths over 90 radii

Sections: { 2-12 in. Channels—latticed, or 2-12 in. Channels and 2 side plates 14 in. wide; B = 8¼ in. C = 11¼ in.

Length of Col. in ft.									
	Lat. 41.0 lbs. r=4.61	5/16 Pl. 70.8 lbs. r=4.40	3/8 Pl. 76.7 lbs. r=4.38	7/16 Pl. 82.6 lbs. r=4.35	1/2 Pl. 88.6 lbs. r=4.33	9/16 Pl. 94.6 lbs. r=4.32	5/8 Pl. 100.5 lbs. r=4.30	11/16 Pl. 106.4 lbs. r=4.29	3/4 Pl. 112.4 lbs. r=4.27
32	......	124.9	135.4	145.9	156.4	166.9	177.4	187.9	198.4
34	72.4	123.0	133.0	142.9	152.9	162.8	172.8	182.8	192.7
36	70.9	119.7	129.4	139.1	148.8	158.4	168.1	177.8	187.4
38	69.1	116.5	125.9	135.3	144.6	154.0	163.4	172.8	182.1
40	67.3	113.3	122.4	131.5	140.5	149.6	158.7	167.8	176.8
42	65.5	110.0	118.8	127.6	136.4	145.2	154.0	162.8	171.5
44	63.7	106.8	115.3	123.8	132.3	140.8	149.3	157.8	166.2
	Lat. 50.0 lbs. r=4.43	7/16 Pl. 91.6 lbs. r=4.30	1/2 Pl. 97.6 lbs. r=4.29	9/16 Pl. 103.6 lbs. r=4.27	5/8 Pl. 109.5 lbs. r=4.26	11/16 Pl. 115.4 lbs. r=4.25	3/4 Pl. 121.4 lbs. r=4.24	13/16 Pl. 127.3 lbs. r=4.23	7/8 Pl. 133.3 lbs. r=4.22
30	......	......	......	......	193.2	203.7	214.2	224.7	235.2
32	88.2	161.7	172.2	182.7	192.6	202.9	213.1	223.3	233.6
34	87.1	157.6	167.6	177.5	187.5	197.4	207.3	217.3	227.2
36	84.8	153.3	163.0	172.6	182.3	191.9	201.6	211.2	220.9
38	82.6	149.1	158.4	167.8	177.1	186.5	195.8	205.2	214.5
40	80.3	144.8	153.8	162.9	172.0	181.0	190.1	199.1	208.2
42	78.0	140.5	149.3	158.0	166.8	175.5	184.3	193.1	201.9
44	75.7	136.2	144.7	153.2	161.6	170.1	178.6	187.0	195.5
	Lat. 60.0 lbs. r=4.28	9/16 Pl. 113.6 lbs. r=4.23	5/8 Pl. 119.5 lbs. r=4.22	11/16 Pl. 125.4 lbs. r=4.21	3/4 Pl. 131.4 lbs. r=4.20	13/16 Pl. 137.3 lbs. r=4.20	7/8 Pl. 143.3 lbs. r=4.19	15/16 Pl. 149.3 lbs. r=4.18	1" Pl. 155.2 lbs. r=4.18
30	......	200.3	210.8	221.3	231.8	242.3	252.8	263.3	273.8
32	105.8	199.1	209.3	219.5	229.8	240.0	250.2	260.5	270.7
34	102.9	193.7	203.6	213.5	223.5	233.4	243.3	253.3	263.2
36	100.1	188.3	197.9	207.5	217.2	226.8	236.5	246.1	255.7
38	97.3	182.9	192.2	201.5	210.9	220.2	229.6	238.9	248.2
40	94.4	177.5	186.5	195.5	204.6	213.6	222.7	231.8	240.8
42	91.6	172.0	180.8	189.5	198.3	207.1	215.8	224.6	233.3
	Lat. 70.0 lbs. r=4.17	11/16 Pl. 135.4 lbs. r=4.17	3/4 Pl. 141.4 lbs. r=4.16	13/16 Pl. 147.3 lbs. r=4.16	7/8 Pl. 153.3 lbs. r=4.15	15/16 Pl. 159.3 lbs. r=4.15	1" Pl. 165.2 lbs. r=4.14	1 1/8 Pl. 177.1 lbs. r=4.14	1 1/4 Pl. 189.0 lbs. r=4.13
30	123.5	239.0	249.5	260.0	270.5	281.0	291.5	312.5	333.5
32	121.9	235.9	246.2	256.4	266.6	276.8	287.1	307.6	328.0
34	118.6	229.4	239.3	249.2	259.2	269.1	279.0	299.0	318.8
36	115.2	222.9	232.5	242.1	251.7	261.4	271.0	290.3	309.6
38	111.8	216.3	225.7	235.0	244.3	253.7	263.0	281.7	300.4
40	108.4	209.8	218.8	227.8	236.9	245.9	255.0	273.1	291.2
42	105.1	203.2	212.0	220.7	229.5	238.2	247.0	264.5	282.0
	Lat. 80.0 lbs. r=4.09	13/16 Pl. 157.3 lbs. r=4.12	7/8 Pl. 163.3 lbs. r=4.11	15/16 Pl. 16[illegible].3 lbs. r=4.11	1" Pl. 175.2 lbs. r=4.11	1 1/8 Pl. 187.1 lbs. r=4.10	1 1/4 Pl. 199.0 lbs. r=4.10	1 3/8 Pl. 210.9 lbs. r=4.10	1 1/2 Pl. 222.8 lbs. r=4.09
30	141.1	277.6	288.1	298.6	309.1	330.1	351.1	372.1	393.1
32	138.2	272.6	282.8	293.0	303.2	323.7	344.1	364.6	385.0
34	134.2	264.9	274.8	284.8	294.7	314.5	334.4	354.2	374.1
36	130.3	257.2	266.8	276.5	286.1	305.4	324.6	343.9	363.1
38	126.3	249.5	258.8	268.2	277.5	296.2	314.9	333.5	352.2
40	122.4	241.8	250.9	259.9	268.9	287.0	305.1	323.2	341.3
42	118.5	234.1	242.9	251.6	260.3	277.8	295.3	312.8	330.3

the above weights of column shaft add the weight of rivets and lattice bars.

ULTIMATE STRENGTH OF COLU
MEDIUM STEEL

For different proportions of length in feet (=l).
To least radius of gyration in inches (=r).
Ultimate Strength in pounds per square inch:

Column
Square Bearing:
$$\frac{50000}{1+\frac{(12l)^2}{36000\ r^2}}.$$

Column
Pin and Square Bearing:
$$\frac{50000}{1+\frac{(12l)^2}{24000\ r^2}}.$$

Column
Pin Bearin
$$\frac{50000}{1+\frac{(12l)^2}{18000\ r}}$$

To obtain Safe Resistance:
For quiescent loads, as in buildings, divide by 4.
For moving loads, as in bridges, divide by 5.

$\frac{l}{r}$	Ultimate Strength in Pounds per Square Inch		
	Square	Pin and Square	Pin
3.0	48260	47440	46640
3.2	48030	47110	46210
3.4	47790	46760	45770
3.6	47540	46390	45300
3.8	47270	46010	44820
4.0	46990	45620	44330
4.2	46710	45210	43820
4.4	46410	44800	43300
4.6	46100	44370	42760
4.8	45780	43930	42220
5.0	45460	43480	41670
5.2	45120	43020	41110
5.4	44780	42560	40540
5.6	44430	42080	39970
5.8	44070	41600	39400
6.0	43710	41120	38820
6.2	43340	40630	38240
6.4	42960	40140	37660
6.6	42580	39640	37080
6.8	42200	39140	36500
7.0	41810	38640	35920
7.2	41410	38140	35340
7.4	41020	37640	34770
7.6	40620	37130	34200
7.8	40210	36630	33630
8.0	39810	36130	33070
8.2	39400	35630	32510
8.4	38990	35130	31960
8.6	38590	34630	31410
8.8	38180	34140	30879

$\frac{l}{r}$	Ultimate Strength in P per Square Inch	
	Square	Pin and Square
9.0	37760	33650
9.2	37350	33160
9.4	36940	32680
9.6	36530	32200
9.8	36120	31720
10.0	35710	31250
10.2	35310	30780
10.4	34900	30320
10.6	34500	29870
10.8	34090	29420
11.0	33690	28970
11.2	33290	28530
11.4	32900	28090
11.6	32510	27670
11.8	32110	27240
12.0	31730	26820
12.2	31340	26410
12.4	30960	26010
12.6	30580	25610
12.8	30210	25210
13.0	29830	24830
13.2	29460	24450
13.5	28930	23890
13.8	28380	23340
14.0	28030	22980
14.2	27680	22630
14.5	27180	22110
14.8	26650	21610
15.0	26320	21280
15.2	25990	[illegible]

ULTIMATE STRENGTH OF COLUMNS—Continued

$\frac{l}{r}$	Ultimate Strength in Pounds per Square Inch			$\frac{l}{r}$	Ultimate Strength in Pounds per Square Inch		
	Square	Pin & Square	Pin		Square	Pin & Square	Pin
15.5	25500	20490	17110	18.5	21100	16380	13380
15.8	25020	20020	16680	18.8	20720	16020	13060
16.0	24700	19720	16400				
16.2	24390	19420	16130	19.0	20460	15790	12860
16.5	23940	18990	15740	19.2	20210	15570	12660
16.8	23490	18560	15350	19.5	19840	15240	12360
17.0	23190	18290	15100	19.8	19470	14920	12090
17.2	22900	18020	14850				
17.5	22480	17630	14490	20.0	19230	14710	11910
17.8	22050	17240	14150	20.2	19000	14500	11730
18.0	21780	16980	13920	20.5	18650	14200	11460
18.2	21510	16740	13700	20.8	18310	13910	11210

RADII OF GYRATION FOR TWO ANGLES PLACED BACK TO BACK

ANGLES WITH EQUAL LEGS

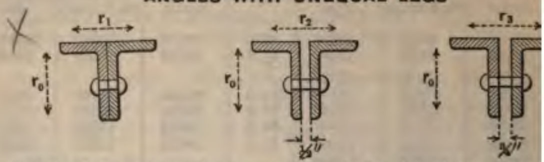
Radii of Gyration given correspond to directions indicated by arrow heads.

Size Inches	Thickness Inches	Area of Single Angle Square Inches	Weight per Foot of Single Angle Pounds	Radii of Gyration			
				r_0	r_1	r_2	r_3
8 ×8	½	7.75	26.4	2.50	3.32	3.49	3.58
8 ×8	1⅛	16.73	56.9	2.42	3.42	3.60	3.69
6 ×6	⅜	4.36	14.9	1.88	2.49	2.67	2.76
6 ×6	1	11.00	37.4	1.80	2.59	2.77	2.87
*5 ×5	⅜	3.61	12.3	1.56	2.09	2.26	2.35
*5 ×5	1	9.00	30.6	1.48	2.19	2.38	2.48
4 ×4	5/16	2.40	8.2	1.24	1.67	1.85	1.94
4 ×4	13/16	5.84	19.9	1.18	1.75	1.94	2.04
3½×3½	5/16	2.09	7.2	1.08	1.47	1.65	1.74
3½×3½	13/16	5.03	17.1	1.02	1.55	1.74	1.85
3 ×3	¼	1.44	4.9	0.93	1.25	1.43	1.53
3 ×3	⅝	3.36	11.5	0.88	1.32	1.51	1.62
*2¾×2¾	¼	1.31	4.5	0.85	1.15	1.34	1.44
*2¾×2¾	½	2.50	8.5	0.82	1.19	1.39	1.49
2½×2½	3/16	0.90	3.1	0.78	1.04	1.22	1.32
2½×2½	½	2.25	7.7	0.74	1.10	1.29	1.40
*2¼×2¼	3/16	0.81	2.8	0.70	0.94	1.12	1.23
*2¼×2¼	½	2.00	6.8	0.66	0.99	1.19	1.30

Angles marked * are special

RADII OF GYRATION FOR TWO ANGLES PL
BACK TO BACK

ANGLES WITH UNEQUAL LEGS



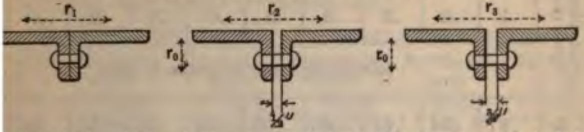
Radii of Gyration given correspond to directions indic arrow heads.

Size Inches	Thickness Inches	Area of Single Angle Square Inches	Weight per Foot of Single Angle Pounds	Radii of Gyration		
				r_0	r_1	r_2
*8 ×3½	11/16	6.02	20.5	2.58	1.17	1.35
*7 ×3½	7/16	4.40	15.0	2.26	1.21	1.39
*7 ×3½	1	9.50	32.3	2.19	1.31	1.50
6 ×4	3/8	3.61	12.3	1.93	1.50	1.67
6 ×4	1	9.00	30.6	1.85	1.60	1.79
6 ×3½	3/8	3.42	11.7	1.94	1.26	1.43
6 ×3½	1	8.50	28.9	1.85	1.37	1.56
*5 ×4	3/8	3.23	11.0	1.59	1.58	1.75
*5 ×4	7/8	7.11	24.2	1.52	1.66	1.85
5 ×3½	5/16	2.56	8.7	1.61	1.33	1.50
5 ×3½	7/8	6.67	22.7	1.53	1.42	1.61
5 ×3	5/16	2.40	8.2	1.61	1.09	1.26
5 ×3	13/16	5.84	19.9	1.55	1.18	1.37
*4½×3	5/16	2.25	7.7	1.44	1.13	1.31
*4½×3	13/16	5.43	18.5	1.38	1.25	1.46
*4 ×3½	5/16	2.25	7.7	1.26	1.42	1.60
*4 ×3½	13/16	5.43	18.5	1.19	1.50	1.69
4 ×3	5/16	2.09	7.2	1.27	1.17	1.35
4 ×3	13/16	5.03	17.1	1.21	1.25	1.45
3½×3	5/16	1.93	6.6	1.10	1.22	1.40
3½×3	13/16	4.62	15.8	1.04	1.30	1.50
3½×2½	1/4	1.44	4.9	1.12	0.96	1.13
3½×2½	11/16	3.65	12.5	1.06	1.03	1.23
*3¼×2	1/4	1.25	4.3	1.04	0.74	0.92
*3¼×2	9/16	2.64	9.0	1.00	0.79	0.99
3 ×2½	1/4	1.31	4.5	0.95	1.00	1.18
3 ×2½	9/16	2.78	9.5	0.91	1.05	1.25
*3 ×2	1/4	1.19	4.1	0.96	0.75	0.93
*3 ×2	1/2	2.25	7.7	0.92	0.80	1.00
2½×2	3/16	0.81	2.8	0.79	0.79	0.97
2½×2	1/2	2.00	6.8	0.75	0.84	1.04

Angles marked * are special

II OF GYRATION FOR TWO ANGLES PLACED BACK TO BACK

ANGLES WITH UNEQUAL LEGS



adii of Gyration given correspond to directions indicated by
heads.

ize ches	Thickness Inches	Area of Single Angle Square Inches	Weight per Foot of Single Angle Pounds	Radii of Gyration			
				r_0	r_1	r_2	r_3
×3½	11/16	6.02	20.5	0.90	3.95	4.14	4.24
×3½	7/16	4.40	15.0	0.95	3.37	3.56	3.66
×3½	1	9.50	32.3	0.89	3.48	3.68	3.78
×4	3/8	3.61	12.3	1.17	2.74	2.92	3.01
×4	1	9.00	30.6	1.09	2.85	3.04	3.14
×3½	3/8	3.42	11.7	0.99	2.81	3.00	3.10
×3½	1	8.50	28.9	0.92	2.93	3.13	3.23
×4	3/8	3.23	11.0	1.20	2.20	2.38	2.48
×4	7/8	7.11	24.2	1.14	2.29	2.48	2.58
×3½	5/16	2.56	8.7	1.03	2.26	2.44	2.54
×3½	7/8	6.67	22.7	0.96	2.36	2.55	2.65
×3	5/16	2.40	8.2	0.85	2.33	2.51	2.61
×3	13/16	5.84	19.9	0.80	2.42	2.62	2.72
×3	5/16	2.25	7.7	0.88	2.06	2.24	2.34
×3	13/16	5.43	18.5	0.81	2.15	2.35	2.45
×3½	5/16	2.25	7.7	1.07	1.73	1.91	2.00
×3½	13/16	5.43	18.5	1.01	1.81	2.01	2.11
×3	5/16	2.09	7.2	0.89	1.79	1.97	2.07
×3	13/16	5.03	17.1	0.83	1.88	2.08	2.18
×3	5/16	1.93	6.6	0.90	1.52	1.71	1.80
×3	13/16	4.62	15.8	0.85	1.61	1.81	1.91
×2½	1/4	1.44	4.9	0.74	1.58	1.76	1.86
×2½	11/16	3.65	12.5	0.67	1.66	1.86	1.96
×2	1/4	1.25	4.3	0.57	1.51	1.70	1.80
×2	9/16	2.64	9.0	0.53	1.57	1.77	1.88
×2½	1/4	1.31	4.5	0.75	1.31	1.50	1.59
×2½	9/16	2.78	9.5	0.72	1.37	1.56	1.66
×2	1/4	1.19	4.1	0.58	1.38	1.56	1.66
×2	1/2	2.25	7.7	0.55	1.42	1.62	1.73
×2	3/16	0.81	2.8	0.60	1.10	1.28	1.39
×2	1/2	2.00	6.8	0.56	1.16	1.35	1.46

*Angles marked * are special*

RADII OF GYRATION FOR ROUND CO

Outside Diameter of Column in Inches	Thickness in Inches Varying by Tenths							
	.1	.2	.3	.4	.5	.6	.7	.8
	Corresponding Radius of Gyration in Inches							
2	.67	.64	.61	.58	.56	.54	.52	.51
3	1.03	.99	.96	.93	.90	.88	.85	.83
4	1.38	1.35	1.31	1.28	1.25	1.22	1.19	1.16
5	1.73	1.70	1.66	1.63	1.60	1.57	1.54	1.51
6	2.08	2.05	2.02	1.98	1.95	1.92	1.89	1.86
7	2.43	2.40	2.36	2.33	2.30	2.27	2.24	2.21
8	2.79	2.76	2.72	2.69	2.66	2.62	2.59	2.56
9	3.15	3.11	3.08	3.04	3.01	2.97	2.94	2.91
10	3.51	3.47	3.44	3.40	3.37	3.33	3.30	3.27
11	3.86	3.82	3.79	3.75	3.72	3.68	3.65	3.62
12	4.21	4.18	4.15	4.11	4.08	4.04	4.01	3.97

RADII OF GYRATION FOR SQUARE CO

Outer Diameter Across Flats in Inches	Thickness in Inches Varying by Tenths							
	.1	.2	.3	.4	.5	.6	.7	.8
	Corresponding Radius of Gyration in Inches							
2	.78	.74	.71	.68	.65	.63	.61	.59
3	1.18	1.14	1.11	1.08	1.04	1.01	.98	.96
4	1.59	1.55	1.51	1.47	1.44	1.41	1.38	1.35
5	2.00	1.96	1.92	1.89	1.85	1.81	1.78	1.75
6	2.41	2.37	2.33	2.29	2.25	2.21	2.18	2.15
7	2.82	2.78	2.74	2.70	2.66	2.62	2.58	2.55
8	3.23	3.19	3.15	3.11	3.07	3.03	2.99	2.96
9	3.63	3.59	3.55	3.51	3.48	3.44	3.40	3.36
10	4.04	4.00	3.96	3.92	3.88	3.84	3.80	3.77
11	4.45	4.41	4.37	4.33	4.29	4.25	4.21	4.17
12	4.86	4.82	4.78	4.74	4.70	4.66	4.62	4.58

LTIMATE STRENGTH OF HOLLOW ROUND AND HOLLOW RECTANGULAR CAST IRON COLUMNS

ate Strength in Pounds per Square Inch:

Round Columns			Rectangular Columns		
Bearing	Pin & Square	Pin Bearing	Square Bearing	Pin & Square	Pin Bearing
$\frac{00}{\frac{2l)^2}{0\ d^2}}$	$\frac{80000}{1+\frac{3(12l)^2}{1600\ d^2}}$	$\frac{80000}{1+\frac{(12l)^2}{400\ d^2}}$	$\frac{80000}{1+\frac{3(12l)^2}{3200\ d^2}}$	$\frac{80000}{1+\frac{9(12l)^2}{6400\ d^2}}$	$\frac{80000}{1+\frac{3(12l)^2}{1600\ d^2}}$

l=Length of column in feet,
d=External diameter or least side of rectangle in inches.

ROUND COLUMNS Ultimate Strength in Pounds per Sq. Inch			RECTANGULAR COLUMNS Ultimate Strength in Pounds per Sq. Inch		
Square Bearing	Pin and Square	Pin Bearing	Square Bearing	Pin and Square	Pin Bearing
67800	62990	58820	70480	66520	62990
65690	60300	55730	68790	64260	60300
63530	57600	52690	67000	61940	57600
61340	54930	49740	65140	59600	54960
59140	52310	46900	63260	57270	52320
56940	49770	44200	61350	54960	49760
54760	47300	41630	59450	52680	47300
52620	44940	39210	57550	50460	44960
50530	42670	36930	55670	48300	42670
48490	40510	34790	53800	46230	40510
46510	38460	32790	51940	44200	38460
44600	36520	30920	50160	42260	36520
42750	34680	29180	48400	40400	34680
40980	32940	27540	46670	38630	32950
39280	31310	26030	44990	36930	31310
37650	29770	24620	43390	35310	29760
36090	28320	23300	41820	33770	28320
34600	26950	22070	40320	32310	26950
33180	25670	20930	38870	30920	25670
31820	24460	19860	37470	29600	24460
30530	23320	18870	36120	28340	23320
29310	22250	17940	34830	27150	22250
28140	21250	17070	33580	26030	21250
27030	20300	16260	32390	24960	20300
25970	19410	15500	31240	23940	19410

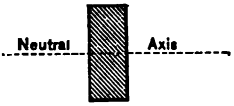
RADII OF GYRATION FOR [illegible]

Outside Diameter of Column in Inches	Thickness in Inches [illegible]				
	.1	.2	.3	.4	.5
	Corresponding Radius [illegible]				
2	.67	.64	.61	.58	.56
3	1.03	.99	.96	.93	.90
4	1.38	1.35	1.31	1.28	1.25
5	1.73	1.70	1.66	1.63	1.60
6	2.08	2.05	2.02	1.98	1.95
7	2.43	2.40	2.36	2.33	2.30
8	2.79	2.76	2.72	2.69	2.66
9	3.15	3.11	3.08	3.04	3.01
10	3.51	3.47	3.44	3.40	3.37
11	3.86	3.82	3.79	3.75	3.72
12	4.21	4.18	4.15	4.11	4.08

RADII OF GYRATION FOR [illegible]

Outer Diameter Across Flats in Inches	Thickness in Inches [illegible]					
	.1	.2	.3	.4	.5	[illegible]
	Corresponding Radius of [illegible]					
2	.78	.74	.71	.68	.65	[illegible]
3	1.18	1.14	1.11	1.08	1.04	[illegible]
4	1.59	1.55	1.51	1.47	1.44	[illegible]
5	2.00	1.96	1.92	1.89	1.85	1.81
6	2.41	2.37	2.33	2.29	2.25	2.21
7	2.82	2.78	2.74	2.70	2.66	2.62
8	3.23	3.19	3.15	3.11	3.07	[illegible]
9	3.63	3.59	3.55	3.51	3.48	3.44
10	4.04	4.00	3.96	3.92	3.88	[illegible]
11	4.45	4.41	4.37	4.33	4.29	[illegible]
12	4.86	4.82	4.78	4.74	4.70	[illegible]

OF INERTIA OF RECTANGLES



Width of Rectangle in Inches

3/8	7/16	1/2	9/16	5/8
6.75	7.88	9.00	10.13	11.25
10.72	12.51	14.29	16.08	17.86
16.00	18.67	21.33	24.00	26.67
22.78	26.58	30.38	34.17	37.97
31.25	36.46	41.67	46.87	52.08
41.59	48.53	55.46	62.39	69.32
54.00	63.00	72.00	81.00	90.00
68.66	80.10	91.54	102.98	114.43
85.75	100.04	114.33	128.63	142.92
105.47	123.05	140.63	158.20	175.78
128.00	149.33	170.67	192.00	213.33
153.53	179.12	204.71	230.30	255.89
182.25	212.63	243.00	273.38	303.75
214.34	250.07	285.79	321.52	357.24
250.00	291.67	333.33	375.00	416.67
289.41	337.64	385.88	434.11	482.34
332.75	388.21	443.67	499.13	554.58
380.22	443.59	506.96	570.33	633.70
432.00	504.00	576.00	648.00	720.00
488.28	569.66	651.04	732.42	813.80
549.25	640.79	732.33	823.88	915.42
615.09	717.61	820.13	922.64	1025.16
686.00	800.33	914.67	1029.00	1143.33
762.16	889.18	1016.21	1143.23	1270.26
843.75	984.38	1125.00	1265.63	1406.25
930.97	1086.13	1241.30	1396.46	1551.62
1024.00	1194.67	1365.33	1536.00	1706.67
1123.03	1310.20	1497.38	1684.55	1871.72
1228.25	1432.96	1637.67	1842.38	2047.08
1339.84	1563.15	1786.46	2009.76	2233.07
1458.00	1701.00	1944.00	2187.00	2430.00
1582.90	1846.72	2110.54	2374.35	2638.17
1714.75	2000.54	2286.33	2572.13	2857.92
1853.72	2162.67	2471.62	2780.58	3089.53
2000.00	2333.33	2666.67	3000.00	3333.33

EXPLANATION OF TABLES ON BEAM BOX GIRDERS

An economical style of box girder well adapted for short spans is one composed of a pair of I-beams with top and bottom flange plates. Such girders are commonly used for supporting interior walls in buildings. The tables are prepared to conform to standard sizes of I-beams.

The values given in the tables are founded upon the moments of inertia of the various sections. Deductions were made for the rivet holes in both flanges. The maximum stress in extreme fibers was limited to 15,000 lbs. per square inch, while in the tables on rolled steel beams a fiber stress of 16,000 lbs. was used. This reduction was made in order to amply compensate for the deterioration of the metal around the rivet holes from punching.

Box girders should not be used in damp or exposed places, since the interior surfaces do not readily admit of repainting.

EXAMPLE

A 13-in. brick wall 16 feet high is to be built over an opening of 25 ft. What will be the section of the girder required?

Answer:—Assuming 26 feet as the distance center to center of bearings the weight of the wall will be $26 \times 16 \times 121 =$ 50,336 lbs., or 25.17 tons.

On page 153 we find that a girder composed of two 12-in. beams each weighing 31.5 lbs. per foot and two $14 \times \frac{1}{2}$ in. flange plates will carry safely for a span of 26 ft. a uniformly distributed load of 25.37 tons, including its own weight. Deducting the latter, 1.48 tons given in the next column, we find 23.89 tons for the value of the safe net load, which is 1.28 tons less than required. From the following column we find that by increasing the thickness of the flange plates $\frac{1}{16}$ in. we may add 1.68 tons to the allowable load. This will more than cover the difference. Hence, the required section will be two 12-in. beams 31.5 lbs. per foot and two $14 \times \frac{9}{16}$ in. cover plates.

BEAM BOX GIRDERS

SAFE LOADS IN TONS UNIFORMLY DISTRIBUTED

2—10 in. I-Beams and 2 Plates 12 in. × ½ in.

2 Plates
12×½

10 in.
I-Beams
25.0 lbs.
per Foot

Safe Load Uniformly Distributed (Including Weight of Girder) in Tons of 2,000 lbs.	Weight of Girder (Including Rivet Heads) in Tons of 2,000 lbs.	Increase in Safe Load for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates	Increase of Weight of Girder for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates
45.00	0.47	3.06	0.02
40.92	0.52	2.78	0.03
37.50	0.56	2.55	0.03
34.62	0.61	2.35	0.03
32.15	0.66	2.18	0.03
30.00	0.70	2.04	0.04
28.13	0.75	1.90	0.04
26.47	0.80	1.80	0.04
25.00	0.84	1.70	0.04
23.69	0.89	1.60	0.05
22.50	0.94	1.53	0.05
21.43	0.99	1.45	0.05
20.46	1.03	1.38	0.05
19.57	1.08	1.32	0.06
18.75	1.13	1.28	0.06
18.00	1.17	1.22	0.06
17.31	1.22	1.18	0.06
16.67	1.27	1.13	0.07
16.07	1.31	1.10	0.07
15.52	1.36	1.05	0.07
15.00	1.41	1.02	0.07
14.52	1.45	0.99	0.08
14.07	1.50	0.96	0.08
13.64	1.55	0.92	0.08
13.23	1.59	0.90	0.08
12.85	1.64	0.88	0.09
12.50	1.69	0.85	0.09
12.16	1.74	0.83	0.09
11.84	1.78	0.81	0.09
11.54	1.83	0.78	0.10

ve values are based on maximum fiber stress of 15,000 lbs. per *inch; $\frac{13}{16}$ in. rivet holes in both flanges deducted.* Weights of *orrespond to* lengths center to center of bearings.

BEAM BOX GIRDERS

SAFE LOADS IN TONS UNIFORMLY DISTRIBUTED

2—12 in. I-Beams and 2 Plates 14 in. × ½ in.

2 Plates 14×½

12 in. I-Beams 40.0 lbs. per Foot

12 in. I-Beams 31.5 lbs. per Foot

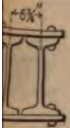
Distance Center to Center of Bearings in Feet	Safe Load Uniformly Distributed (Including Weight of Girder) in Tons of 2,000 lbs.	Weight of Girder (Including Rivet Heads) in Tons of 2,000 lbs.	Increase in Safe Load for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates	Safe Load Uniformly Distributed (Including Weight of Girder) in Tons of 2,000 lbs.	Weight of Girder (Including Rivet Heads) in Tons of 2,000 lbs.	Increase in Safe Load for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates
10	73.33	0.65	4.33	65.97	0.57	4.40
11	66.67	0.72	3.93	59.98	0.63	3.99
12	61.11	0.78	3.61	54.98	0.68	3.66
13	56.40	0.85	3.33	50.75	0.74	3.38
14	52.37	0.91	3.09	47.12	0.80	3.14
15	48.89	0.98	2.88	43.98	0.85	2.93
16	45.83	1.05	2.70	41.23	0.91	2.75
17	43.13	1.11	2.55	38.80	0.97	2.58
18	40.73	1.18	2.40	36.65	1.02	2.45
19	38.60	1.24	2.27	34.72	1.08	2.31
20	36.67	1.31	2.17	32.99	1.14	2.19
21	34.92	1.37	2.07	31.42	1.19	2.09
22	33.33	1.44	1.97	29.99	1.25	2.00
23	31.88	1.50	1.88	28.68	1.31	1.92
24	30.55	1.57	1.80	27.48	1.36	1.83
25	29.33	1.63	1.73	26.39	1.42	1.75
26	28.20	1.70	1.66	25.37	1.48	1.68
27	27.16	1.76	1.60	24.44	1.53	1.63
28	26.19	1.83	1.55	23.56	1.59	1.57
29	25.28	1.89	1.49	22.75	1.65	1.51
30	24.44	1.96	1.44	21.99	1.70	1.47
31	23.65	2.02	1.40	21.28	1.76	1.42
32	22.92	2.09	1.35	20.62	1.81	1.37
33	22.22	2.16	1.32	20.00	1.87	1.33
34	21.57	2.22	1.27	19.41	1.93	1.29
35	20.95	2.29	1.23	18.85	1.99	1.26
36	20.37	2.35	1.20	18.32	2.05	1.22
37	19.82	2.42	1.17	17.83	2.10	1.19
38	19.29	2.48	1.14	17.37	2.16	1.15
39	18.81	2.55	1.11	16.92	2.21	1.13

Above values are based on maximum fiber stress of 15,000 l
square inch; $\frac{13}{16}$ in. rivet holes in both flanges deducted. Wei
girders correspond to lengths center to center of bearings.

BEAM BOX GIRDERS

SAFE LOADS IN TONS UNIFORMLY DISTRIBUTED

2-15 in. I-Beams and 2 Plates 14 in. × ⅝ in.



15 in. I-Beams 80.0 lbs. per Foot

Plates 14 in. × ⅝ in.

15 in. I-Beams 60.0 lbs. per Foot

2 Plates 14 in. × ⅝ in.

15 in. I-Beams 42.0 lbs. per Foot

2 Plates 14 in. × ⅝ in.

15 in. I-Beams 80.0 lbs. per Foot; Plates 14 in. × ⅝ in.			15 in. I-Beams 60.0 lbs. per Foot; 2 Plates 14 in. × ⅝ in.			15 in. I-Beams 42.0 lbs. per Foot; 2 Plates 14 in. × ⅝ in.			
Safe Load Uniformly Distributed (Including Weight of Girder) in Tons of 2,000 lbs.	Weight of Girder (Including Rivet Heads) in Tons of 2,000 lbs.	Increase in Safe Load for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates	Safe Load Uniformly Distributed (Including Weight of Girder) in Tons of 2,000 lbs.	Weight of Girder (Including Rivet Heads) in Tons of 2,000	Increase in Safe Load for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates	Safe Load Uniformly Distributed (Including Weight of Girder) in Tons of 2,000 lbs.	Weight of Girder (Including Rivet Heads) in Tons of 2,000 lbs.	Increase in Safe Load for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates	Increase in Weight of Girder for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates
146.00	1.11	5.17	124.86	0.91	5.33	106.08	0.73	5.47	0.03
132.73	1.22	4.70	113.50	1.00	4.85	96.44	0.81	4.97	0.03
121.66	1.34	4.30	104.05	1.10	4.44	88.41	0.88	4.56	0.03
112.30	1.45	3.98	96.05	1.19	4.10	81.60	0.95	4.21	0.04
104.28	1.56	3.69	89.18	1.28	3.81	75.77	1.03	3.91	0.04
97.34	1.67	3.45	83.24	1.37	3.55	70.73	1.10	3.65	0.04
91.25	1.78	3.28	78.03	1.46	3.33	66.30	1.18	3.43	0.05
85.88	1.89	3.05	73.44	1.55	3.14	62.40	1.25	3.22	0.05
81.12	2.00	2.87	69.37	1.64	2.97	58.94	1.32	3.05	0.05
76.85	2.11	2.72	65.71	1.73	2.80	55.83	1.39	2.88	0.05
73.00	2.23	2.58	62.43	1.83	2.67	53.04	1.47	2.73	0.06
69.52	2.34	2.46	59.46	1.92	2.54	50.52	1.54	2.61	0.06
66.37	2.45	2.35	56.76	2.01	2.42	48.22	1.61	2.49	0.06
63.47	2.56	2.25	54.29	2.10	2.32	46.12	1.68	2.38	0.07
60.83	2.67	2.16	52.03	2.19	2.23	44.20	1.76	2.28	0.07
58.40	2.78	2.07	49.94	2.28	2.13	42.44	1.83	2.19	0.07
56.16	2.89	1.98	48.02	2.37	2.05	40.80	1.90	2.10	0.08
54.07	3.00	1.92	46.25	2.46	1.97	39.29	1.98	2.03	0.08
52.14	3.12	1.85	44.60	2.56	1.90	37.89	2.05	1.95	0.08
50.34	3.23	1.78	43.05	2.65	1.83	36.59	2.12	1.89	0.08
48.67	3.34	1.72	41.62	2.74	1.78	35.37	2.20	1.82	0.09
47.10	3.45	1.67	40.28	2.83	1.72	34.22	2.27	1.77	0.09
45.62	3.56	1.62	39.02	2.92	1.66	33.15	2.34	1.71	0.09
44.24	3.67	1.57	37.83	3.01	1.62	32.15	2.42	1.66	0.10
42.95	3.78	1.52	36.73	3.10	1.57	31.20	2.49	1.62	0.10
41.71	3.89	1.48	35.68	3.19	1.52	30.31	2.56	1.57	0.10
40.56	4.01	1.43	34.68	3.29	1.48	29.47	2.64	1.52	0.10
39.46	4.12	1.40	33.75	3.38	1.44	28.67	2.71	1.48	0.11
38.42	4.23	1.36	32.86	3.47	1.41	27.92	2.78	1.44	0.11
37.43	4.34	1.33	32.02	3.56	1.36	27.20	2.86	1.42	0.11

Above values are based on maximum fiber stress of 15,000 lbs. per are *inch; ⅞ in. rivet holes* in both flanges deducted. Weights of *ers correspond to lengths* center to center of bearings.

BEAM BOX GIRDERS

SAFE LOADS IN TONS UNIFORMLY DISTRIB

2 Plates 16×¾  18 in. I-Beams 55 lbs. per Foot				2 Plates 16×¾ 	
Distance Center to Center of Bearings in Feet	Safe Load Uniformly Distributed (Including Weight of Girder) in Tons of 2,000 lbs.	Weight of Girder (Including Rivet Heads) in Tons of 2,000 lbs.	Increase in Safe Load for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates	Safe Load Uniformly Distributed (Including Weight of Girder) in Tons of 2,000 lbs.	Weight of Girder (Including Rivet Heads) in Tons of 2,000 lbs.
10	170.23	0.98	7.52	231.98	1.22
11	154.76	1.08	6.84	210.89	1.35
12	141.86	1.18	6.27	193.33	1.47
13	130.95	1.27	5.78	178.44	1.59
14	121.59	1.37	5.38	165.70	1.71
15	113.49	1.47	5.02	154.65	1.83
16	106.39	1.57	4.70	144.99	1.96
17	100.14	1.66	4.42	136.47	2.08
18	94.57	1.76	4.18	128.87	2.20
19	89.60	1.86	3.96	122.10	2.32
20	85.12	1.96	3.76	116.00	2.45
21	81.06	2.06	3.58	110.47	2.57
22	77.38	2.15	3.42	105.45	2.69
23	74.01	2.25	3.27	100.87	2.81
24	70.93	2.35	3.14	96.67	2.94
25	68.09	2.45	3.01	92.79	3.06
26	65.47	2.55	2.90	89.23	3.18
27	63.05	2.64	2.78	85.92	3.30
28	60.80	2.74	2.69	82.85	3.42
29	58.70	2.84	2.60	80.01	3.55
30	56.74	2.94	2.50	77.33	3.67
31	54.91	3.03	2.42	74.84	3.79
32	53.20	3.13	2.35	72.51	3.91
33	51.59	3.23	2.28	70.29	4.04
34	50.07	3.33	2.22	68.24	4.16
35	48.64	3.43	2.15	66.28	4.28
36	47.29	3.52	2.09	64.45	4.40
37	46.01	3.62	2.03	62.70	4.53
38	44.80	3.72	1.98	61.05	4.65
39	43.65	3.82	1.93	59.49	4.77

Above values are based on maximum fiber stress of
square inch; $\frac{13}{16}$ in. rivet holes in both flanges deducte
girders correspond to lengths center to center of beari

BEAM BOX GIRDERS

SAFE LOADS IN TONS UNIFORMLY DISTRIBUTED

2 Plates 16×¾

20 in. I-Beams 65.0 lbs. per Foot

2 Plates 18×¾

24-In. I-Beams 80.0 lbs. per Foot

Distance Center to Center of Bearings in Feet	Safe Load Uniformly Distributed (Including Weight of Girder) in Tons of 2,000 lbs.	Weight of Girder (Including Rivet Heads) in Tons of 2,000 lbs.	Increase in Safe Load for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates	Increase of Weight in Girder for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates	Distance Center to Center of Bearings in Feet	Safe Load Uniformly Distributed (Including Weight of Girder) in Tons of 2,000 lbs.	Weight of Girder (Including Rivet Heads) in Tons of 2,000 lbs.	Increase in Safe Load for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates	Increase in Weight of Girder for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates
10	205.88	1.07	8.47	0.03	14	211.98	1.78	8.28	0.05
11	187.15	1.18	7.70	0.04	15	197.86	1.91	7.73	0.06
12	171.57	1.29	7.06	0.04	16	185.49	2.04	7.25	0.06
13	158.37	1.39	6.52	0.04	17	174.58	2.17	6.82	0.06
14	147.06	1.50	6.05	0.05	18	164.88	2.29	6.45	0.07
15	137.25	1.61	5.64	0.05	19	156.21	2.42	6.10	0.07
16	128.68	1.72	5.30	0.05	20	148.40	2.55	5.80	0.08
17	121.11	1.82	4.98	0.06	21	141.32	2.68	5.53	0.08
18	114.31	1.93	4.71	0.06	22	134.91	2.80	5.27	0.08
19	108.36	2.04	4.45	0.06	23	129.04	2.93	5.04	0.09
20	102.93	2.15	4.23	0.07	24	123.66	3.06	4.83	0.09
21	98.05	2.25	4.03	0.07	25	118.72	3.19	4.64	0.09
22	93.58	2.36	3.85	0.07	26	114.15	3.31	4.47	0.10
23	89.52	2.47	3.68	0.08	27	109.91	3.44	4.29	0.10
24	85.78	2.58	3.53	0.08	28	105.99	3.57	4.14	0.11
25	82.36	2.68	3.39	0.08	29	102.33	3.69	4.00	0.11
26	79.19	2.79	3.25	0.09	30	98.93	3.82	3.87	0.11
27	76.25	2.90	3.14	0.09	31	95.73	3.95	3.74	0.12
28	73.52	3.00	3.02	0.09	32	92.75	4.08	3.62	0.12
29	71.00	3.11	2.92	0.10	33	89.93	4.20	3.53	0.12
30	68.63	3.22	2.83	0.10	34	87.29	4.33	3.42	0.13
31	66.42	3.33	2.73	0.10	35	84.80	4.46	3.31	0.13
32	64.34	3.43	2.64	0.11	36	82.44	4.59	3.22	0.14
33	62.39	3.54	2.56	0.11	37	80.22	4.71	3.14	0.14
34	60.55	3.65	2.49	0.11	38	78.10	4.84	3.06	0.14
35	58.82	3.76	2.42	0.12	39	76.10	4.97	2.98	0.15
36	57.18	3.86	2.35	0.12	40	74.19	5.10	2.90	0.15
37	55.64	3.97	2.28	0.12	41	72.39	5.22	2.83	0.16
38	54.17	4.08	2.23	0.13	42	70.66	5.35	2.76	0.16
39	52.80	4.18	2.17	0.13	43	69.02	5.48	2.70	0.16
....	....	.....	.....	.....	44	67.45	5.61	2.64	0.17
....	....	.....	.....	.....	45	65.95	5.73	2.57	0.17

Above values are based on maximum fiber stress of 15,000 lbs. pe *square inch;* $\frac{13}{16}$ *in.* rivet holes in both flanges deducted. Weights *girders correspond to lengths center to center of bearings.*

EXPLANATION OF TABLES ON RIVETED PLATE GIRDERS

Riveted girders are used where rolled beams are insufficient carry the load. On page 47 of the lithograph plates will be found illu trations of various forms of riveted girders. The sections with sing webs are more economical than those with double webs, but the latt are stiffer laterally and should always be used where great length span requires a wide top flange. If the girder is not held in positi sideways, the proportion of length of span to width of flange should n exceed twenty without making provision for such increase by an add tion of metal in the compression flange beyond that required by tl table.

The web of the girder must be made of such thickness that the will be no tendency to buckle and that the vertical shearing stress p square inch will not exceed 10,000 lbs. This shearing stress is greate near the supports and is obtained by dividing half the load upon tl girder (provided the load is symmetrically applied) by the web sectio The first condition (security against buckling) is attained when th shearing stress does not exceed $\dfrac{12,000}{1+\dfrac{d^2}{3,000t^2}}$ in which d represents t depth of girder out to out of flange angles and t the thickness of one w plate in inches. Ordinarily this formula gives a lower stress per squa inch than 10,000 pounds, so that both conditions are usually attain when the first is. Instead of increasing the thickness of the web it m be stiffened by means of vertical angles riveted to it at proper interva These latter should always be less than the depth of the girder. at le near the ends, but toward the middle of the girder the stiffeners may placed further apart or entirely omitted. Stiffeners should always used at or near the supports and at any other point where there is a co centration of heavy loads. The duty of these stiffeners in such cases twofold; first, to prevent buckling of the web; second, to transmit t shear to the web by means of the abutting areas and the rivets, both which must be sufficient for the purpose.

The rivets generally should be ¾ in. and the spacing in flanges oug not to exceed 6 in. and should be closer for heavy flanges; but in cases it should be close at the ends, say 3 in. for a distance equal to t depth of the girder. Where loads are great especial calculation for riv spacing should be made.

The unsupported width of flange plates subjected to compressi should not exceed 32 times their thickness, nor should the flange pla extend beyond the outer line of rivets more than 5 in., nor more th eight times their thickness.

The term "flange," as applied to the riveted girders, embraces *the metal in top or* bottom of girder exclusive of web plate; or, in t *case of a rolled* beam or channel with top and bottom plates, all t *metal exclusive of* that part of the web between fillets.

lers intended to carry plastering should be limited in depth from ut to $\frac{1}{20}$ of the span length ($\frac{5}{8}$ in. per foot); otherwise the deflection e to cause the plastering to crack.

e following pages, Nos. 159 to 162 inclusive, furnish a ready means rmining the sections of plate or box girders necessary to carry ed loads for spans varying from 20 to 40 feet, center to center of gs.

e "Safe Loads" are given for the section shown and in columns l "Increase in Safe Load" is given the increase in safe load for in. increase in thickness of flange plates. The flange plates may ered in width and thickness, provided the section remains the as that required in the table and the conditions in regard to ported width be fulfilled.

EXAMPLE

30 in. box girder is to carry a load of 80 tons over a clear span of 30 What section of girder is required? The span from center to of bearings we will assume to be 31 feet.

the table, page 161, the safe load for this span and for the girder is found to be 72.65 tons including weight of girder, which latter, ling to the table, may be assumed at about 3.5 tons. The total load carried is, therefore, 83.5 tons. The increase in safe load for $\frac{1}{16}$ in. se in thickness of flange plate given in the table is 4.27 tons. The ess of the flange plate is then obtained as follows: 83.5 tons—72.65 10.85 tons. This÷4.27 tons is very nearly 3. Each flange plate ore, must be increased by $\frac{3}{16}$ in., making a total thickness of flange of $\frac{9}{16}$ in.

e section of the girder is then composed of two $30 \times \frac{1}{2}$ in. web , two $16 \times \frac{9}{16}$ in. flange plates (which could be made $18 \times \frac{1}{2}$ in. or in., etc.—see previous note) and four $3\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$ in. flange angles.

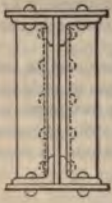
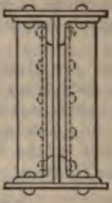
hear in one web is $\frac{83.5 \times 2{,}000}{2 \times 2 \times 30 \times \frac{1}{2}}$ or 2,785 pounds per square inch which

safe against buckling, since it is less than $\dfrac{12{,}000}{1 + \dfrac{d^2}{3{,}000t^2}}$ which,

case, is 5,454 pounds.

PLATE GIRDERS

SAFE LOADS IN TONS UNIFORMLY DISTRIBUTED

Distance Center to Center of Bearings in Feet	 30 in. × ½ in. Web Plate; 12 in. × ⅜ in. Flange Plates; 5 × 3½ × ½ in. Angles				 33 in. × ½ in. Web Plate; 12 in. × ⅜ in. Flange Plates; 5 × 3½ × ½ in.			
	Safe Load, Including Weight of Girder	Weight of Girder	Increase in Safe Load for 1/16 in. Increase in Thickness of Flange Plates	Increase in Weight of Girder for 1/16 in. Increase in Thickness of Flange Plates	Safe Load, Including Weight of Girder	Weight of Girder	Increase in Safe Load for 1/16 in. Increase in Thickness of Flange Plates	Increase in Weight
20	93.67	1.62	4.62	.05	105.82	1.70	5.08	
21	89.22	1.69	4.38	.05	100.78	1.77	4.85	
22	85.15	1.76	4.19	.06	96.20	1.84	4.62	
23	81.46	1.86	4.00	.06	92.01	1.95	4.42	
24	78.07	1.93	3.83	.06	88.18	2.02	4.23	
25	74.94	2.01	3.68	.06	84.65	2.09	4.06	
26	72.06	2.07	3.54	.07	81.39	2.17	3.91	
27	69.40	2.14	3.42	.07	78.38	2.24	3.76	
28	66.91	2.21	3.29	.07	75.58	2.31	3.63	
29	64.60	2.31	3.17	.07	72.98	2.42	3.50	
30	62.45	2.38	3.07	.08	70.55	2.49	3.39	
31	60.44	2.45	2.97	.08	68.26	2.56	3.29	
32	58.55	2.52	2.88	.08	66.14	2.64	3.17	
33	56.77	2.59	2.79	.08	64.13	2.71	3.08	
34	55.11	2.66	2.70	.09	62.24	2.78	2.99	
35	53.53	2.73	2.63	.09	60.46	2.85	2.91	
36	52.04	2.83	2.56	.09	58.79	2.96	2.83	
37	50.63	2.90	2.49	.09	57.20	3.03	2.75	
38	49.30	2.97	2.42	.10	55.70	3.11	2.67	
39	48.03	3.04	2.37	.10	54.27	3.18	2.60	
40	46.83	3.11	2.31	.10	52.90	3.25	2.55	

The above values are founded on the moments of inertia of the se[ctions] *using a maximum* fiber stress of 15,000 lbs. per square inch; 15/16 in. [rivet] *holes in both flanges* deducted. Weights of girders correspond to [...] *[c]enter to center of* bearings and include rivet heads, stiffeners an[d]

PLATE GIRDERS

SAFE LOADS IN TONS UNIFORMLY DISTRIBUTED

36 in. × ½ in. Web Plate
12 in. × ⅜ in. Flange Plates
5 × 3½ × ½ in. Angles

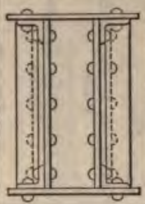
42 in. × ⅝ in. Web Plate
14 in. × ⅜ in. Flange Plates
6 × 6 × ⅝ in. Angles

ing Weight of Girder	Weight of Girder	Increase in Safe Load for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates	Increase in Weight of Girder for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates	Safe Load, Including Weight of Girder	Weight of Girder	Increase in Safe Load for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates	Increase in Weight of Girder for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates
8.35	1.77	5.54	.05	176.01	2.72	7.74	·06
2.70	1.85	5.28	.05	167.63	2.84	7.37	.06
7.57	1.92	5.04	.06	160.02	2.95	7.03	.07
2.90	2.04	4.82	.06	153.06	3.12	6.73	.07
8.61	2.17	4.63	.06	146.68	3.24	6.44	.07
4.66	2.19	4.44	.06	140.82	3.36	6.18	.07
1.02	2.26	4.27	.07	135.39	3.48	5.95	.08
7.65	2.34	4.11	.07	130.38	3.59	5.73	.08
4.53	2.41	3.96	.07	125.73	3.71	5.52	.08
1.61	2.53	3.82	.07	121.38	3.88	5.34	.09
8.89	2.60	3.70	.08	117.35	4.00	5.17	.09
6.34	2.68	3.58	.08	113.56	4.12	4.98	.09
3.96	2.75	3.46	.08	110.01	4.23	4.85	.10
1.72	2.82	3.36	.08	106.67	4.35	4.70	.10
9.61	2.89	3.27	.09	103.55	4.47	4.55	.10
7.62	2.98	3.17	.09	100.58	4.59	4.42	.10
5.75	3.09	3.07	.09	97.78	4.76	4.30	.11
3.97	3.16	2.99	.09	95.15	4.87	4.18	.11
2.28	3.24	2.91	.10	92.64	4.99	4.07	.11
0.69	3.31	2.85	.10	90.27	5.11	3.97	.12
9.14	3.39	2.77	.10	88.00	5.23	3.87	.12

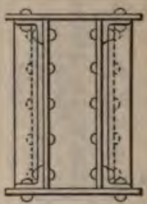
bove values are founded on the moments of inertia of the sections maximum fiber stress of 15,000 lbs. per square inch; ⅞ in. rivet *both flanges* deducted. Weights of girders correspond to lengths *center of bearings* and include rivet heads, stiffeners and fillers.

BOX GIRDERS

SAFE LOADS IN TONS UNIFORMLY DISTRIBUTED



30 in. × ½ in. Web Plates
16 in. × ⅜ in. Flange Plates
3½ × 3½ × ½ in. Angles



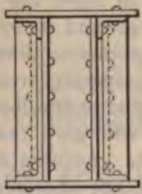
33 in. × ½ in. Web Plates
20 in. × $\frac{7}{16}$ in. Flange Plates
3½ × 3½ × ½ in. Angles

Distance Center to Center of Bearings in Feet	30 in. × ½ in. Web Plates; 16 in. × ⅜ in. Flange Plates; 3½ × 3½ × ½ in. Angles: Safe Load, Including Weight of Girder	Weight of Girder	Increase in Safe Load for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates	Increase in Weight of Girder for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates	33 in. × ½ in. Web Plates; 20 in. × $\frac{7}{16}$ in. Flange Plates; 3½ × 3½ × ½ in. Angles: Safe Load, Including Weight of Girder	Weight of Girder	Increase in Safe Load for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates	Increase in Weight of Girder for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates
20	112.60	2.13	6.61	.07	150.2	2.44	9.17	.09
21	107.24	2.23	6.30	.07	143.1	2.55	8.75	.09
22	102.37	2.32	6.00	.08	136.5	2.66	8.33	.09
23	97.92	2.45	5.75	.08	130.6	2.80	7.96	.10
24	93.83	2.54	5.52	.08	125.2	2.91	7.64	.10
25	90.08	2.64	5.30	.09	120.1	3.03	7.33	.11
26	86.62	2.74	5.09	.09	115.5	3.14	7.06	.11
27	83.41	2.83	4.90	.09	111.2	3.25	6.80	.12
28	80.42	2.93	4.73	.10	107.3	3.36	6.54	.12
29	77.65	3.06	4.57	.10	103.6	3.50	6.32	.12
30	75.07	3.16	4.41	.10	100.2	3.61	6.10	.13
31	72.65	3.25	4.27	.11	96.9	3.72	5.92	.13
32	70.38	3.35	4.13	.11	93.9	3.83	5.73	.14
33	68.24	3.50	4.02	.11	91.0	3.95	5.56	.14
34	66.23	3.54	3.90	.12	88.4	4.06	5.39	.14
35	64.34	3.64	3.78	.12	85.8	4.17	5.23	.15
36	62.56	3.76	3.67	.12	83.4	4.31	5.09	.15
37	60.87	3.86	3.57	.13	81.2	4.41	4.96	.16
38	59.26	3.95	3.48	.13	79.0	4.53	4.82	.16
39	57.74	4.05	3.39	.13	77.0	4.65	4.70	.17
40	56.31	4.15	3.30	.14	75.1	4.76	4.58	.17

The above values are founded on the moments of inertia of the sections using a maximum fiber stress of 15,000 lbs. per square inch; $\frac{13}{16}$ in. rivet holes in both flanges deducted. Weights of girders correspond to length center to center of bearings and include rivet heads, stiffeners and filler

BOX GIRDERS

SAFE LOADS IN TONS UNIFORMLY DISTRIBUTED



Distance Center to Center of Bearings in Feet	36 × ½ in. Web Plates; 24 × $\frac{9}{16}$ in. Flange Plates. 4 × 3½ × ½ in. Angles				42 × ½ in. Web Plates; 30 × $\frac{11}{16}$ in. Flange Plates; 5 × 3½ × ½ in. Angles			
	Safe Load, Including Weight of Girder	Weight of Girder	Increase in Safe Load for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates	Increase in Weight of Girder for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates	Safe Load, Including Weight of Girder	Weight of Girder	Increase in Safe Load for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates	Increase in Weight of Girder for $\frac{1}{16}$ in. Increase in Thickness of Flange Plates
20	213.3	2.92	12.22	.10	329.2	3.74	18.29	.13
21	203.3	3.06	11.65	.11	313.5	3.91	17.41	.13
22	194.1	3.19	11.12	.11	299.2	4.09	16.63	.14
23	185.5	3.36	10.64	.12	286.2	4.30	15.90	.15
24	177.9	3.49	10.20	.12	274.3	4.48	15.24	.15
25	170.8	3.63	9.78	.13	263.3	4.65	14.63	.16
26	164.3	3.76	9.44	.13	253.2	4.83	14.07	.17
27	158.1	3.89	9.06	.14	243.8	5.00	13.55	.17
28	152.4	4.03	8.73	.14	235.2	5.17	13.06	.18
29	147.2	4.15	8.43	.15	227.0	5.39	12.61	.19
30	142.3	4.33	8.15	.15	219.5	5 57	12.18	.19
31	137.7	4.45	7.88	.16	212.3	5.74	11.79	.20
32	133.4	4.60	7.65	.16	205.7	5.91	11.42	.20
33	129.3	4.74	7.42	.17	199.5	6.08	10.08	.21
34	125.5	4.87	7.20	·17	193.6	6.25	10.75	.22
35	122.0	5.00	6.99	.18	188.1	6.43	10.45	.22
36	118.6	5.17	6.81	.18	182.9	6.65	10.15	.23
37	115.4	5.31	6.62	.19	177.9	6.82	9.89	.24
38	112.4	5.44	6.44	.19	173.2	6.90	9.62	.24
39	109.5	5.58	6.28	.20	168.8	7.16	9.38	.25
40	106.7	5.71	6.12	.20	164.5	7.34	9.14	.26

The above values are founded on the moments of inertia of the sections using a *maximum fiber stress* of 15,000 lbs. per square inch; $\frac{13}{16}$ in. rivet *holes in both flanges deducted.* Weights of girders correspond to lengths *center to center* of bearings and include rivet heads, stiffeners and fillers

I-BEAMS AS USED IN FOUNDATIONS
METHOD OF CALCULATION

The known quantities in this calculation are the lo on the column in tons, the allowable bearing capacit square foot of ground in tons (b) and the projection p″ in feet for the various tiers of beams.

Figure the separate areas covered by the successiv of beams and divide the load on the column by these The quotients will give their respective pressures b, per square foot. Assume any spacing in inches, ge greatest for the lowest tier of beams and about 9 in. f top course.

Find the corresponding figure for such spacing and sure in the table and multiply it by the corresponding p tion. This product will give the modulus M.

In the table of moduli find the beam corresponding t product.

For any other spacing or pressure than those given f from the formula $M = p\sqrt{\frac{sb}{12}}$.

EXAMPLE

Let L=588 tons ⎰ Assume p=3 ft. 6 in., p′=5 ft. 3 in. 1 ft. 9 in.
Let b= 3 tons ⎱ Then b′=6 tons and b″=24 tons.

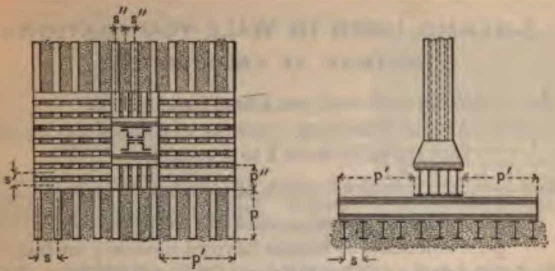
Use 15 in. spacing for lowest tier of beams
" 12 " " " 2d " " "
" 9 " " " 3d " " "

Now using the above method of calculation we ha the respective tiers:

3.5×1.937=6.78=Modulus corresponding to 12 in. 3 beam.

5.25×2.450=12.86=Modulus corresponding to 20 in. beam.

1.75×4.243=7.43=Modulus corresponding to 12 in. beam.



BLES GIVING THE SIZE AND WEIGHT OF BEAMS FOR s=9-12-15-18-24 INCHES, b=1 TO 50 TONS PER SQUARE FOOT AND p=VARIABLE IN FEET

In Inches	Weight per Foot	Moduli	Depth of Beam in Inches	Weight per Foot	Moduli
4	100	16.263	12	50.00	8.210
4	90	15.772	12	40.00	7.730
4	80	15.231	12	35.00	7.122
0	100	14.858	12	31.50	6.925
0	90	14.412	10	40.00	6.505
0	80	13.983	10	30.00	5.982
0	75	13.007	10	25.00	5.706
0	65	12.488	9	35.00	5.755
8	70	11.683	9	25.00	5.220
8	60	11.168	9	21.00	5.016
8	55	10.857	8	25.50	4.776
5	100	12.653	8	20.50	4.494
5	90	12.259	8	18.00	4.354
5	80	11.892	7	20.00	4.009
5	75	11.085	7	15.00	3.715
5	70	10.862	6	17.25	3.412
5	60	10.405	6	12.25	3.112
5	55	9.532	5	14.75	2.842
5	50	9.270	5	9.75	2.539
5	42	8.861	4	10.50	2.182
12	55	8.415	4	7.50	1.994

Tons per Square Foot	SPACING OF I-BEAMS				
	9''	12''	15''	18''	24''
1	0.866	1.000	1.118	1.225	1.414
2	1.225	1.414	1.581	1.732	2.000
3	1.500	1.732	1.937	2.121	2.450
4	1.732	2.000	2.236	2.450	2.829
5	1.936	2.236	2.500	2.738	3.162
6	2.121	2.450	2.739	3.000	3.464
7	2.291	2.646	2.958	3.240	3.742
8	2.450	2.828	3.162	3.463	4.000
9	2.598	3.000	3.354	3.674	4.243
10	2.738	3.162	3.536	3.872	4.472
11	2.872	3.317	3.708	4.061	4.690
12	3.000	3.464	3.873	4.242	4.899
13	3.122	3.606	4.031	4.415	5.099
14	3.240	3.742	4.184	4.582	5.292
15	3.354	3.873	4.331	4.743	5.477
16	3.464	4.000	4.472	4.898	5.657
17	3.571	4.123	4.610	5.050	5.831
18	3.674	4.243	4.744	5.196	6.000
19	3.775	4.359	4.874	5.338	6.164
20	3.873	4.472	5.000	5.477	6.325
21	3.969	4.583	5.124	5.612	6.481
22	4.062	4.690	5.244	5.744	6.633
23	4.153	4.796	5.362	5.873	6.783
24	4.243	4.899	5.477	6.000	6.928
25	4.330	5.000	5.591	6.123	7.071
30	4.743	5.477	6.124	6.707	7.746
35	5.124	5.916	6.615	7.245	8.366
40	5.477	6.325	7.071	7.746	8.945
45	5.810	6.708	7.500	8.215	9.487
50	6.124	7.071	7.906	8.660	10.000

I-BEAMS USED IN WALL FOUNDATION

METHOD OF CALCULATION

Let L = Weight of wall per lineal foot in tons
and b = Assumed bearing capacity of ground per squ
foot (usually from 1 to 3 tons);

then $\frac{L}{b}$ = W = Required width of foundation in feet.
w = Width of lowest course of footing-stones.
p = Projection of beams beyond masonry in feet.
s = Spacing of beams center to center in feet.

Evidently the size of beams required will depend upon strength as cantilevers of a length "p" sustaining the u reaction, which may be regarded as a uniformly distributed

Thus p b = uniformly distributed load (in tons) on levers per lineal foot of wall
and p b s = uniform load in tons on each beam.

The table on the following page gives the safe length for the various sizes and weights of beams for s = 1 ft. and ranging from 1 to 5 tons per square foot. For other val "s," say 15 in. or 1¼ ft., the table may be used by s considering "b" increased in the same ratio as "s" example below). As regards the weight of beams, it is a tageous to assign to "s" as great a value as is warrant the other considerations which obtain.

EXAMPLE

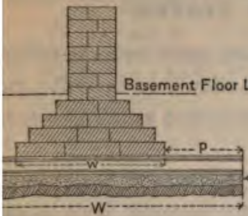
The weight of a brick wall together with the load it support is 40 tons per lineal foot. The width of the l footing-course of masonry is 6 ft. Allowing a pressur tons per square foot on the foundation, what size and len I-beams 18 in. center to center will be required?

Answer—L = 40, b = 2, w = 6, s = 1½.

Therefore W = 40 ÷ 2 = 20 ft., the required length of b The projection "p" = ½ (20-6) = 7 feet.

In order to apply the table (calculated for s = 1 ft.) we consider "b" increased in the same ratio as "s," *i. e* 2 × 1½ = 3 tons.

In the column for 3 tons we find the length 7 ft. to *with 20 in.* I-beams 65.0 lbs. per foot.



: GIVING SAFE LENGTHS OF PROJEC-
NS "p" IN FEET (SEE ILLUSTRATION)
OR "s"=1 FOOT AND VALUES OF "b"
RANGING FROM 1 TO 5 TONS

	b (TONS PER SQUARE FOOT)										
	1	1¼	1½	2	2¼	2½	3	3½	4	4½	5
0	15.231	13.61	12.43	10.77	10.16	9.63	8.79	8.14	7.62	7.18	6.81
0	13.983	12.50	11.41	9.89	9.32	8.84	8.07	7.47	6.90	6.59	6.25
0	12.488	11.16	10.20	8.82	8.33	7.90	7.21	6.68	6.24	5.89	5.58
0	10.857	9.71	8.86	7.68	7.23	6.87	6.27	5.80	5.43	5.12	4.86
0	11.892	10.63	9.71	8.41	7.93	7.52	6.86	6.36	5.95	5.61	5.32
0	10.405	9.30	8.49	7.36	6.94	6.58	6.01	5.56	5.20	4.90	4.65
0	8.861	7.92	7.23	6.27	5.91	5.60	5.12	4.74	4.43	4.18	3.96
0	7.730	6.91	6.31	5.47	5.15	4.89	4.46	4.13	3.87	3.64	3.46
0	6.925	6.19	5.65	4.90	4.55	4.38	4.00	3.70	3.46	3.26	3.10
0	5.706	5.10	4.66	4.03	3.80	3.61	3.29	3.05	2.85	2.69	2.55
0	5.016	4.48	4.09	3.55	3.34	3.17	2.90	2.68	2.51	2.36	2.24
0	4.354	3.89	3.55	3.08	2.90	2.75	2.51	2.33	2.18	2.05	1.95
0	3.715	3.32	3.03	2.63	2.48	2.35	2.14	1.98	1.86	1.75	1.66
5	3.112	2.78	2.54	2.20	2.07	1.97	1.80	1.66	1.56	1.47	1.39
5	2.539	2.27	2.07	1.80	1.69	1.61	1.47	1.36	1.27	1.20	1.14
0	1.994	1.78	1.63	1.41	1.33	1.26	1.15	1.07	1.00	0.94	0.89

ize of beam for any other pressure is found by multiplying the n by the square root of the assumed pressure and finding the *ing a projection* corresponding to this product under the one *n.*

BUCKLED PLATES

A new form of buckled plate, made in long leng several buckles to the plate, is shown on opposite pa this form the plate is usually supported at the two lon only.

Buckled plates are used for the floors of fireproof b and bridges. They are usually covered with con asphalt and stone paving, etc. They are generally r length and width from 3 ft. to 4 ft. 6 in., and in thic of ¼ to ⅜ in.; they are very strong, as indicated by lowing table. In order to allow for some deteriora corrosion they are, however, rarely made thinner than while $\frac{5}{16}$ in. is a usual thickness for bridge floors.

There has not yet been a reliable formula devis which the strength of buckled plates can be figured, b experiments on plates 3 ft. square, arched 2 in. and we down on all sides, the following table of quiescent sa uniformly distributed has been deduced.

Thickness Inches	Approximate Weight of One Plate Pounds	Safe Load (One-fourth of Ultimate Load) Pounds	Per Sq Po
¼	93.0	10080	1
$\frac{5}{16}$	116.5	13888	1
⅜	139.5	20160	2

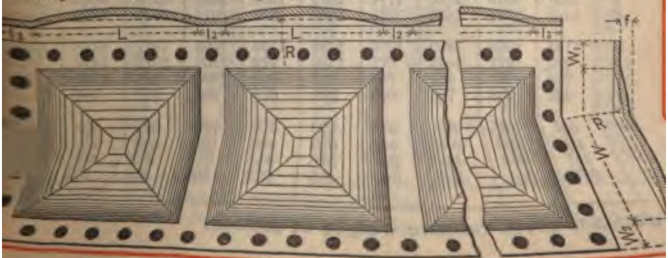
The resistance of buckled plates bolted or rivete all around is double the resistance of the same plate supported all around, and if the two opposite sides ported, the resistance is reduced in the proportion

MENSIONS OF STANDARD BUCKLED PLATES

(Not manufactured by Carnegie Steel Company)

Size of Buckle: Side L ft. in.	Size of Buckle: Side W ft. in.	Rise "f" of Buckle	Radii of Buckle = R: For L ft. in.	Radii of Buckle = R: For W ft. in.	Number of Buckles in One Plate	Widths of Flanges and Fillets: End Flgs 11 and 13	Widths of Flanges and Fillets: Fillets 12	Widths of Flanges and Fillets: Side Flgs W 1 & W 2	No. of Connection Holes per Buckle: For L	No. of Connection Holes per Buckle: For W
3 11	4 6	3½	6 8⅝	8 9⅞	1 to 7	Minimum=2"—Preferably made alike—Maximum=1′ 6" If longer than 1′ 6", then use angles riveted across the plate for stiffeners	Minimum=2"—Maximum=6" Best not to exceed 4"	Minimum=2"—Preferably made alike—Maximum=6" Best not to exceed 4"	8	9
4 6	3 11	3½	8 9⅞	6 8⅝	1 to 6				9	8
3 11	3 6	3	7 9½	6 3	1 to 7				8	7
3 6	3 11	3	6 3	7 9½	1 to 8				7	8
3 9	3 9	3	7 1⅞	7 1⅞	1 to 8				8	8
3 1	3 9	3	4 10⅝	7 1⅞	1 to 9				7	8
3 9	3 1	3	7 1⅞	4 10⅝	1 to 8				8	7
3 8	3 8	2	10 2	10 2	1 to 8				8	8
2 8	3 8	2	5 5	10 2	1 to 10				6	8
3 8	2 8	2	10 2	5 5	1 to 8				8	6
2 2	3 8	2	3 7¼	10 2	1 to 10				5	8
3 8	2 2	2	10 2	3 7¼	1 to 8				8	5
3 0	3 0	2	6 10	6 10	1 to 9				6	6
2 9	2 9	3	3 10⅞	3 10⅞	1 to 10				6	6
2 6	2 9	2½	3 10¼	4 7⅞	1 to 10				5	6
2 9	2 6	2½	4 7⅞	3 10¼	1 to 10				6	5
2 6	2 6	2½	3 10¼	3 10¼	1 to 10				5	5
3 5	3 6	3	5 11 9/16	6 3	1 to 8				7	7
3 6	3 5	3	6 3	5 11 9/16	1 to 8				7	7
3 6	3 9	3	6 3	7 1⅞	1 to 8				7	8
3 9	3 6	3	7 1⅞	6 3	1 to 8				8	7
3 2	3 1	3	5 1 21/32	4 10⅝	1 to 9				7	7
3 1	3 2	3	4 10⅝	5 1 21/32	1 to 9				7	7
3 0	3 1	3	4 7½	4 10⅝	1 to 9				6	7
3 1	3 0	3	4 10⅝	4 7½	1 to 9				7	6
2 6	2 0	2½	3 10¼	2 6 1/16	1 to 10				5	4
2 0	2 6	2½	2 6 1/16	3 10¼	1 to 15				4	5
5 6	3 6	3½	13 1 21/64	5 4¾	1 to 5				11	7
3 6	5 6	3½	5 4¾	13 1 21/64	1 only				7	11
4 0	4 0	3	8 1½	8 1½	1 to 7				8	

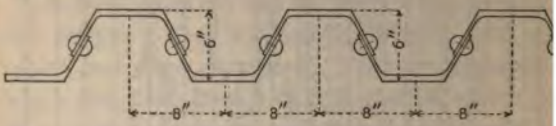
Letters L, 11, 12 and 13 refer to dimensions in length of plate.
Letters W, W 1 and W 2 refer to dimensions in width of plate.
The line between buckle and flange or fillet is not sharply defined on plates.
Plates are made of steel and may be either ¼, 5-16 or ⅜ in. thick.
If plates of greater length than given in the table are required, they may be made by licing with bars, angles or tees.
Connection holes are made either for ⅝ or ¾ in. diameter bolts or rivets, but all les in plate must be same size, as holes of different diameters in the same plate will crease the cost of the plate.
Buckles of different lengths (L) and widths (W) may be used in the same plate, but at will increase the cost of the plate. Buckles of other dimensions than given in this ble may be made, but the making of new dies will be at an additional cost.



TROUGH-PLATE FLOORING

The trough and corrugated plate sections shown on page
for floors of bridges and fireproof buildings, as shown in Fig.

The following tables give weights per lineal foot of
section and per square foot of floor surface for thicknesses
$\frac{1}{16}$ in.; also the section modulus for one foot in width and the
per square foot for spans of different lengths, using fibre
12,000 and 10,000 lbs.



PROPERTIES OF TROUGH SECTION

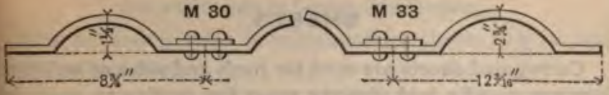
Section index	M 10	M 11	M 12	M
Thickness of base	½	$\frac{9}{16}$	⅝	
Weight per lineal foot	16.3	18.0	19.7	21
Weight per square foot	25.00	28.15	31.31	34
Section Modulus for 1 ft. in width .	11.56	13.06	14.57	16

SAFE LOADS IN POUNDS PER SQUARE FOO
FLOOR FOR SPANS OF DIFFERENT LENGT

Span in Feet	M 10		M 11		M 12		M 13		
	12,000 lbs.	10,000 lbs.	12,000 lbs.	10,000 lbs.	12,000 lbs.	10,000 lbs.	12,000 lbs.	10,000 lbs.	12, 1
5	3699	3083	4179	3483	4662	3885	5158	4298	5
6	2569	2141	2902	2418	3238	2698	3582	2985	3
7	1887	1573	2132	1777	2379	1983	2632	2193	2
8	1445	1204	1633	1361	1821	1517	2015	1679	2
9	1142	952	1290	1075	1439	1199	1592	1327	1
10	925	771	1045	871	1166	972	1200	1075	1
11	764	637	864	720	963	803	1066	888	1
12	642	535	726	605	809	674	896	747	
13	547	456	618	515	690	575	763	636	
14	472	393	533	444	595	496	658	548	
15	411	343	464	387	518	432	573	478	
16	361	301	408	340	455	379	504	420	

Safe loads given include weight of section.

CORRUGATED PLATE FLOORING



PROPERTIES OF CORRUGATED PLATE

Section index	M 30	M 31	M 32	M 33	M 34	M 35
Thickness of metal	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$
Weight per lineal foot . .	8.1	10.1	12.0	17.75	20.71	23.67
Weight per square foot . .	11.05	13.78	16.50	17.47	20.39	23.30
Section Modulus for 1 ft. in width	1.10	1.55	1.95	3.28	3.84	4.39

SAFE LOADS IN POUNDS PER SQUARE FOOT OF FLOOR

Span in Feet	M 30		M 31		M 32	
	12,000 lbs.	10,000 lbs.	12,000 lbs.	10,000 lbs.	12,000 lbs.	10,000 lbs.
5	352	293	496	413	624	520
6	244	203	345	287	433	361
7	180	150	253	211	318	265
8	138	115	194	162	244	203
9	109	91	153	128	193	161
10	88	73	124	103	156	130
11	73	61	103	86	129	108
12	61	51	86	72	108	90
13	52	43	73	61	92	77
14	45	38	63	53	80	67
15	39	33	55	46	69	58
16	35	29	49	41	61	51

Span in Feet	M 33		M 34		M 35	
	12,000 lbs.	10,000 lbs.	12,000 lbs.	10,000 lbs.	12,000 lbs.	10,000 lbs.
5	1049	874	1228	1023	1404	1170
6	728	607	853	711	975	813
7	535	446	627	523	717	598
8	410	342	480	400	549	458
9	324	270	379	316	433	361
10	262	218	307	256	351	293
11	217	181	254	212	290	242
12	182	152	213	178	244	203
13	155	129	182	152	208	173
14	134	112	157	131	179	149
15	117	98	136	113	156	130
16	103	86	120	100	137	114

Safe loads *given include* weight of section.
Weight per square foot given does not include weight of splice plat

CORRUGATED AND GALVANIZED SHEETS

Corrugated sheets are used for roofs and sides of buildin They are usually laid directly upon the purlins in roofs a held in place by means of clips of hoop iron, which encirc the purlin and are placed in distances of about 12 in. apa Special care must be taken that the projecting edges of t corrugated sheets at the eaves and gable ends of the roof a well secured, otherwise the wind will loosen the sheets a fold them up.

The corrugations are made of various sizes; the small present a more pleasing appearance to the eye, while the larg are stiffer and will span a greater distance, thereby permitti the purlins to be placed further apart. The sizes of shee generally used for both roofing and siding are Nos. 20 a 22, B. W. G.

By one corrugation is meant the double curve betwe corresponding points, and by depth of corrugation the greate deviation from the straight line measured between the conca surfaces of the corrugated sheet.

The corrugations are 2.425 in. long measured on th straight line; they require a length of sheet of 2.725 in. t make one corrugation, and the depth of corrugation is $\frac{11}{16}$ i One corrugation is allowed for lap in the width of the she and 6 in. in the length for the usual pitch of roof of two to on Sheets can be corrugated of any length not exceeding 10 f The most advantageous width is 30½ in. which (allowi ½ in. for irregularities) will make 11 corrugations=30 in., making allowance for laps will cover 24¼ in. of the surface the roof.

By actual trial it is found that corrugated sheet No. spanning 6 ft. will begin to give a permanent deflection for load of 30 lbs. per square foot, and that it will collapse with load of 60 lbs. per square foot. The distance between cente of purlins should therefore not exceed 6 ft. and preferably l *less than this.*

CORRUGATED SHEETS

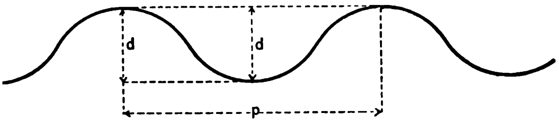
(Not manufactured by Carnegie Steel Company)

ıe following table is calculated for sheets 30⅝ in. wide
: corrugating.

Thickness Inches	Weight per Square Foot Flat Pounds	Weight per Square Foot Corrugated Pounds	Weight per Square of 100 Square Feet when laid, allowing 6 in. Lap in Length and 2½ in. or one Corrugation in Width of Sheet for Sheet Length of:						Weight per Square Foot Flat, Galvanized Pounds
			5′	6′	7′	8′	9′	10′	
.065	2.61	3.28	365	358	353	350	348	346	2.95
.049	1.97	2.48	275	270	267	264	262	261	2.31
.035	1.40	1.76	196	192	190	188	186	185	1.74
.028	1.12	1.41	156	154	152	150	149	148	1.46
.022	.88	1.11	123	121	119	118	117	117	1.22
.018	.72	.91	101	99	97	97	96	95	1.06

TE—For weights per square laid with one and one-half lap add to 5 per cent. For weights per square laid with two laps add to 10 per cent.

TRANSVERSE STRENGTH



l = Unsupported length of sheet in inches.

t = Thickness of sheet in inches.

b = Width of sheet in inches.

d = Depth of corrugations in inches.

W = Breaking weight distributed in tons.

w = Breaking weight distributed in pounds.

$$W = \frac{49.95\ t.\ b.\ d.}{l}$$

$$w = \frac{99900\ t.\ b.\ d.}{l}$$

NOTES ON ROOFS AND LOADS FOR SAM

ANGLES OF ROOFS AS COMMONLY USED

Proportion of Rise to Span	Angle		Length of Rafter to Rise	Proportion of Rise to Span	Angle		Len Rafter
	Deg.	Min.			Deg.	Min.	
½	45	..	1.4142	¼	26	34	2.2
⅓	33	41	1.8028	$\frac{1}{5}$	21	48	2.6
$\frac{1}{2\sqrt{3}}$	30	..	2.0000	$\frac{1}{6}$	18	26	3.1

APPROXIMATE LOADS PER SQUARE FOOT FOR RO OF SPANS UNDER 75 FEET, INCLUDING WEIGHT OF TRUSS

Roof covered with corrugated sheets, unboarded . . . .
Roof covered with corrugated sheets, on boards . . . 1
Roof covered with slate, on laths 1
Same, on boards 1¼ in. thick 1
Roof covered with shingles, on laths 1
Add to above, if plastered below rafters 1
Snow, light, weighs per cubic foot . . . . . . 5 to 1

For spans over 75 ft. add 4 lbs. to the above loads per square fo

It is customary to add 30 lbs. per square foot to the above for and wind when separate calculations are not made.

PRESSURE OF WIND ON ROOFS (Unwin)

a = Angle of surface of roof with direction of wind.
F = Force of wind in pounds per square foot.
A = Pressure normal to surface of roof = F Sin. $a^{1.84 \text{ Cos. } a-1}$.
B = Pressure perpendicular to direction of wind = F Cot. a Sin. $a^{1.84}$
C = Pressure parallel to direction of wind = F Sin. $a^{1.84 \text{ Cos. } a}$.

Angle of roof = a	5°	10°	20°	30°	40°	50°	60°	70°	80°
A = F ×	.125	.24	.45	.66	.83	.95	1.00	1.02	1.01
B = F ×	.122	.24	.42	.57	.64	.61	.50	.35	.17
C = F ×	.01	.04	.15	.33	.53	.73	.85	.96	.99

ROOF TRUSSES

.ES FOR FINDING STRESSES IN MEMBERS FOR ROOF TRUSSES OF THE DIFFERENT TYPES AND PITCHES AS GIVEN BELOW AND OF ANY SPAN

RULE—To find the stress in any member, multiply the ficient given for that member by total dead load carried truss (=span in feet × distance between trusses in feet × ght per square foot). If the truss is acted upon by wind es or other unsymmetrical loading, the stresses in the nbers must be calculated accordingly and combined with dead load stresses as found below.

iber russ	Pitch (Depth to Span)			
	1/3	30°	1/4	1/5
g. 1				
ia	.675	.750	.838	1.010
3b	.537	.625	.726	.917
'a	.563	.650	.750	.938
'c	.375	.433	.500	.625
.b	.208	.217	.224	.232
ıc	.188	.217	.250	.313
g. 2				
ia	.750	.833	.930	1.120
3b	.589	.666	.757	.928
'c	.568	.666	.783	.995
)a	.625	.721	.833	1.042
)d	.375	.433	.500	.625
ıb	.155	.167	.180	.202
)c	.155	.167	.180	.202
:d	.250	.288	.333	.417
g. 3				
ia	.788	.874	.978	1.178
3b	.718	.812	.922	1.131
'c	.649	.750	.866	1.085
)d	.580	.687	.810	1.038
ła	.655	.758	.875	1.094
ℨf	.562	.650	.750	.938
łe	.375	.433	.500	.625
ıb	.104	.108	.112	.116
)f	.093	.108	.125	.156
g	.208	.216	.224	.232
'c	.093	.108	.125	.156
d	.104	.108	.112	.116
'e	.187	.217	.250	.313
ie	.280	.325	.375	.469

NOTE—Heavy lines denote compression and light lines tension members. Loads are considered as concentrated at the joints.

FIG. 1

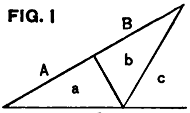


FIG. 2

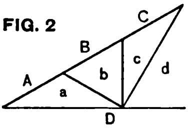
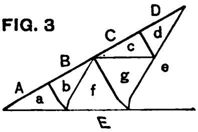


FIG. 3



STANDARD CAST IRON SEPARATORS FOR I-BEAMS

Separators for 18, 20 and 24 in. beams are made of ⅝ in. met
Separators for 6 to 15 in. beams are made of ½ in. metal.
Separators for 5 in. beams and under are made of ⅜ in. met

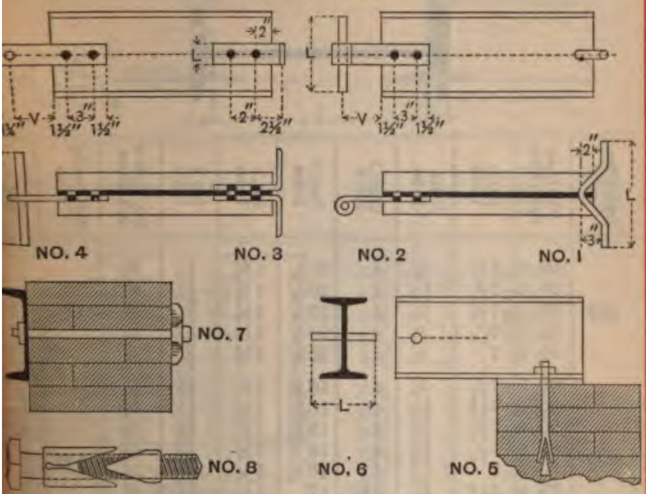
SEPARATORS WITH TWO BOLTS

Designation of Beam			Distances		Bolts			Weights			
Shape Index	Depth, Inches	Weight, Pounds	Out to Out of Flanges of Beams, Inches	Center to Center of Beams, Inches	Size, Inches	Distance Center to Centre, Inches	Length, Inches	Bolts and Nuts, Pounds	Increase in Weight of Separator Bolts for 1 in. Additional Spread of Beams, Pounds	Separator, Pounds	Increase in Weight of Separator for 1 in. Addi-
B 1	24	80	14¾	7¾	¾	12	9¼	3.41	.250	32	5.5
B 2	20	80	14¾	7¾	¾	12	9¼	3.41	.250	28	3.1
B 3	20	65	13¼	7	¾	12	8½	3.23	.250	25	3.1
B 80	18	55	12¾	6¾	¾	9	8¼	3.16	.250	16	2.7
B 4	15	80	13⅝	7¼	¾	7½	9	3.55	.250	15	1.7
B 5	15	60	12¾	6¾	¾	7½	8½	3.23	.250	15	1.7
B 7	15	42	11¾	6¼	¾	7½	7½	2.98	.250	15	1.7
B 8	12	40	11¼	6	¾	5	7½	2.98	.250	11	1.5
B 9	12	31.5	10¾	5¾	¾	5	7¼	2.92	.250	11	1.5

SEPARATORS WITH ONE BOLT

Shape Index	Depth, Inches	Weight, Pounds	Out to Out of Flanges of Beams, Inches	Center to Center of Beams, Inches	Size, Inches	Distance Center to Centre, Inches	Length, Inches	Bolts and Nuts, Pounds	Increase in Weight of Separator Bolts for 1 in. Additional Spread of Beams, Pounds	Separator, Pounds	Increase in Weight of Separator for 1 in. Addi-
B 8	12	40.0	11¼	6	¾	....	7½	1.49	.125	10	1.
B 9	12	31.5	10¾	5¾	¾	....	7¼	1.46	.125	10	1.
B 11	10	25.0	10⅛	5½	¾	....	6¾	1.40	.125	8	1.
B 13	9	21.0	9$\frac{5}{16}$	5	¾	....	6¼	1.34	.125	7	1.
B 15	8	18.0	8½	4½	¾	....	5¾	1.28	.125	6	1.
B 17	7	15.0	7⅝	4¼	¾	....	5½	1.25	.125	4	.
B 19	6	12.25	7$\frac{1}{16}$	4	¾	....	5¼	1.22	.125	4	.
B 21	5	9.75	6½	3½	¾	....	4¾	1.16	.125	3	.
B 23	4	7.50	5⅞	3¼	¾	....	4½	1.13	.125	3	.
B 77	*3*	5.50	5$\frac{5}{16}$	3	⅝	....	4¼	0.70	.09	2	.

ANDARD WALL ANCHORS FOR BEAMS AND CHANNELS

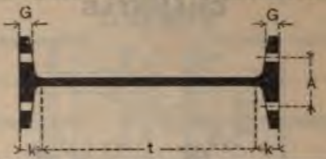


No. of Anchor	Depth of Beam or Channel in Inches	Size of Bar or Angles in Inches	Length L in Inches	Weight in Pounds	No. of Anchor	Depth of Beam or Channel in Inches	Size of Bar or Angles in Inches	Length L in Inches	Weight in Pounds
1	3 to 9 10 to 24	$\frac{3}{4}$	15 18	$2\frac{1}{4}$ $2\frac{3}{4}$	4	3 to 5 6 to 10 10 to 24	$2\frac{1}{4}\times\frac{5}{16}$ $3\times\frac{3}{8}$ $3\times\frac{3}{8}$	12 12 15	V
2	3 to 5 6 to 10 12 to 24	$2\frac{1}{4}\times\frac{5}{16}$ $3\times\frac{3}{8}$ $3\times\frac{3}{8}$	6 6 12	V	6	3 to 9 10 to 24	$\frac{3}{4}$	15 18	2 $2\frac{1}{4}$
3	3 to 5 6 to 10 12 to 24	$6\times4\times\frac{3}{8}$ $6\times6\times\frac{3}{8}$ $6\times6\times\frac{1}{2}$	$2\frac{1}{4}$ 3 3	6 8 11	All weights and dimensions marked V are variable, as are also other figures where not given.				

All material for anchors steel, except Nos. 7 and 8, parts of which may be cast or malleable iron. All anchors are shipped loose and riveted or bolted to beams in the field; and in order to avoid two size holes in the same piece anchors should be so selected that holes for them and their connections may be $\frac{13}{16}$ in. The weights given above include the bolts or rivets for field connections.

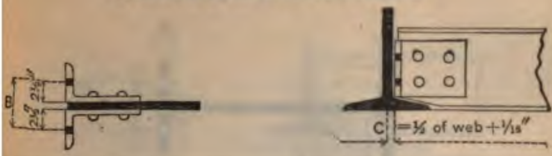
Anchors Nos. 1, 2, 3, 4 and 6 are common in building construction; the split anchor bolts No. 5, with or without wedges, are mostly used for bridge work and column foundations; the washer for No. 7 on outside of wall may be either a cast iron star or a steel plate; expansion bolts No. 8 are of use in repair work to fasten channels, etc., to brick walls.

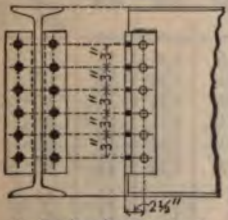
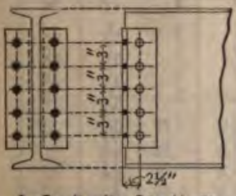
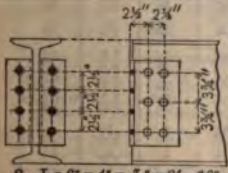
CARNEGIE STANDARDS



Depth of Beam Inches	Weight per Foot, Pounds	Flange Inches	Web Inches	Gauge A Inches	Tangt. t Inches	Dist. k Inches	Grip G Inches	Max. Rivet or Bolt, Inches	Wall Bearing Inches
24	100.0	$7\frac{1}{4}$	$\frac{3}{4}$	4	$20\frac{3}{4}$	$1\frac{5}{8}$	$\frac{27}{32}$	$\frac{7}{8}$	16
	95.0	$7\frac{3}{16}$	$\frac{11}{16}$	4	$20\frac{3}{4}$	$1\frac{5}{8}$	$\frac{27}{32}$	$\frac{7}{8}$	
	90.0	$7\frac{1}{8}$	$\frac{5}{8}$	4	$20\frac{3}{4}$	$1\frac{5}{8}$	$\frac{27}{32}$	$\frac{7}{8}$	
	85.0	$7\frac{1}{16}$	$\frac{9}{16}$	4	$20\frac{3}{4}$	$1\frac{5}{8}$	$\frac{27}{32}$	$\frac{7}{8}$	
	80.0	7	$\frac{1}{2}$	4	$20\frac{3}{4}$	$1\frac{5}{8}$	$\frac{27}{32}$	$\frac{7}{8}$	
20	100.0	$7\frac{9}{32}$	$\frac{7}{8}$	4	$16\frac{1}{2}$	$1\frac{3}{4}$	$\frac{29}{32}$	$\frac{7}{8}$	16
	95.0	$7\frac{13}{64}$	$\frac{51}{64}$	4	$16\frac{1}{2}$	$1\frac{3}{4}$	$\frac{29}{32}$	$\frac{7}{8}$	
	90.0	$7\frac{8}{64}$	$\frac{47}{64}$	4	$16\frac{1}{2}$	$1\frac{3}{4}$	$\frac{29}{32}$	$\frac{7}{8}$	
	85.0	$7\frac{1}{16}$	$\frac{21}{32}$	4	$16\frac{1}{2}$	$1\frac{3}{4}$	$\frac{29}{32}$	$\frac{7}{8}$	
	80.0	7	$\frac{19}{32}$	4	$16\frac{1}{2}$	$1\frac{3}{4}$	$\frac{29}{32}$	$\frac{7}{8}$	
	75.0	$6\frac{13}{32}$	$\frac{21}{32}$	$3\frac{1}{2}$	17	$1\frac{1}{2}$	$\frac{25}{32}$	$\frac{7}{8}$	
	70.0	$6\frac{21}{64}$	$\frac{37}{64}$	$3\frac{1}{2}$	17	$1\frac{1}{2}$	$\frac{25}{32}$	$\frac{7}{8}$	
	65.0	$6\frac{1}{4}$	$\frac{1}{2}$	$3\frac{1}{2}$	17	$1\frac{1}{2}$	$\frac{25}{32}$	$\frac{7}{8}$	
18	70.0	$6\frac{17}{64}$	$\frac{23}{32}$	$3\frac{1}{4}$	$15\frac{1}{4}$	$1\frac{3}{8}$	$\frac{11}{16}$	$\frac{7}{8}$	16
	65.0	$6\frac{11}{64}$	$\frac{5}{8}$	$3\frac{1}{4}$	$15\frac{1}{4}$	$1\frac{3}{8}$	$\frac{11}{16}$	$\frac{7}{8}$	
	60.0	$6\frac{3}{32}$	$\frac{35}{64}$	$3\frac{1}{4}$	$15\frac{1}{4}$	$1\frac{3}{8}$	$\frac{11}{16}$	$\frac{7}{8}$	
	55.0	6	$\frac{29}{64}$	$3\frac{1}{4}$	$15\frac{1}{4}$	$1\frac{3}{8}$	$\frac{11}{16}$	$\frac{7}{8}$	
15	100.0	$6\frac{25}{32}$	$1\frac{3}{16}$	$3\frac{3}{4}$	11	2	$1\frac{1}{32}$	$\frac{7}{8}$	12
	95.0	$6\frac{43}{64}$	$1\frac{5}{64}$	$3\frac{3}{4}$	11	2	$1\frac{1}{32}$	$\frac{7}{8}$	
	90.0	$6\frac{37}{64}$	$\frac{63}{64}$	$3\frac{3}{4}$	11	2	$1\frac{1}{32}$	$\frac{7}{8}$	
	85.0	$6\frac{31}{64}$	$\frac{57}{64}$	$3\frac{3}{4}$	11	2	$1\frac{1}{32}$	$\frac{7}{8}$	
	80.0	$6\frac{13}{32}$	$\frac{13}{16}$	$3\frac{3}{4}$	11	2	$1\frac{1}{32}$	$\frac{7}{8}$	
	75.0	$6\frac{19}{64}$	$\frac{57}{64}$	$3\frac{1}{4}$	$11\frac{3}{4}$	$1\frac{5}{8}$	$\frac{13}{16}$	$\frac{3}{4}$	
	70.0	$6\frac{3}{16}$	$\frac{25}{32}$	$3\frac{1}{4}$	$11\frac{3}{4}$	$1\frac{5}{8}$	$\frac{13}{16}$	$\frac{3}{4}$	
	65.0	$6\frac{3}{32}$	$\frac{11}{16}$	$3\frac{1}{4}$	$11\frac{3}{4}$	$1\frac{5}{8}$	$\frac{13}{16}$	$\frac{3}{4}$	
	60.0	6	$\frac{19}{32}$	$3\frac{1}{4}$	$11\frac{3}{4}$	$1\frac{5}{8}$	$\frac{13}{16}$	$\frac{3}{4}$	
	55.0	$5\frac{3}{4}$	$\frac{21}{32}$	3	$12\frac{1}{2}$	$1\frac{1}{4}$	$\frac{5}{8}$	$\frac{3}{4}$	
	50.0	$5\frac{41}{64}$	$\frac{35}{64}$	3	$12\frac{1}{2}$	$1\frac{1}{4}$	$\frac{5}{8}$	$\frac{3}{4}$	
	45.0	$5\frac{35}{64}$	$\frac{29}{64}$	3	$12\frac{1}{2}$	$1\frac{1}{4}$	$\frac{5}{8}$	$\frac{3}{4}$	
	42.0	$5\frac{1}{2}$	$\frac{13}{32}$	3	$12\frac{1}{2}$	$1\frac{1}{4}$	$\frac{5}{8}$	$\frac{3}{4}$	

CARNEGIE STANDARDS

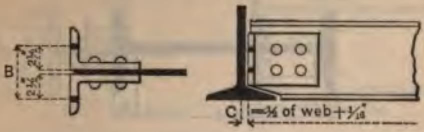


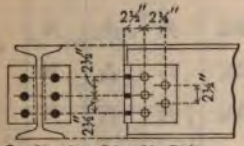
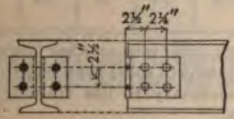
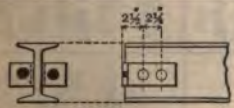
STANDARD FRAMING	Dist. B Inches	Dist. C Inches	Weight per Foot Pounds	Depth of Beam Inches
 2—Ls 4″ x 4″ x $\frac{7}{16}$″ x 1′—6″ Wt. 43 lbs.	$5\frac{3}{4}$	$\frac{7}{16}$	100.0	24
	$5\frac{11}{16}$	$\frac{7}{16}$	95.0	
	$5\frac{5}{8}$	$\frac{3}{8}$	90.0	
	$5\frac{9}{16}$	$\frac{3}{8}$	85.0	
	$5\frac{1}{2}$	$\frac{5}{16}$	80.0	
	$5\frac{7}{8}$	$\frac{1}{2}$	100.0	20
	$5\frac{13}{16}$	$\frac{1}{2}$	95.0	
	$5\frac{3}{4}$	$\frac{7}{16}$	90.0	
	$5\frac{11}{16}$	$\frac{7}{16}$	85.0	
	$5\frac{5}{8}$	$\frac{3}{8}$	80.0	
	$5\frac{11}{16}$	$\frac{7}{16}$	75.0	
 2—Ls 4″ x 4″ x $\frac{7}{16}$″ x 1′—3″ Wt. 36 lbs.	$5\frac{9}{16}$	$\frac{3}{8}$	70.0	
	$5\frac{1}{2}$	$\frac{5}{16}$	65.0	
	$5\frac{3}{4}$	$\frac{7}{16}$	70.0	18
	$5\frac{5}{8}$	$\frac{3}{8}$	65.0	
	$5\frac{9}{16}$	$\frac{3}{8}$	60.0	
	$5\frac{1}{2}$	$\frac{5}{16}$	55.0	
	$6\frac{3}{16}$	$\frac{11}{16}$	100.0	15
	$6\frac{1}{16}$	$\frac{5}{8}$	95.0	
	6	$\frac{9}{16}$	90.0	
	$5\frac{7}{8}$	$\frac{1}{2}$	85.0	
 2—Ls 6″ x 4″ x $\frac{7}{16}$″ x 0′—10″ Wt. 31 lbs.	$5\frac{13}{16}$	$\frac{1}{2}$	80.0	
	$5\frac{7}{8}$	$\frac{1}{2}$	75.0	
	$5\frac{3}{4}$	$\frac{7}{16}$	70.0	
	$5\frac{11}{16}$	$\frac{7}{16}$	65.0	
	$5\frac{5}{8}$	$\frac{3}{8}$	60.0	
	$5\frac{5}{8}$	$\frac{3}{8}$	55.0	
	$5\frac{9}{16}$	$\frac{3}{8}$	50.0	
	$5\frac{1}{2}$	$\frac{5}{16}$	45.0	
	$5\frac{7}{16}$	$\frac{1}{4}$	42.0	

CARNEGIE STANDARDS

Depth of Beam Inches	Weight per Foot, Pounds	Flange, Inches	Web, Inches	Gauge A Inches	Tangent t Inches	Dist. k Inches	Grip G Inches	Max. Rivet or Bolt, Inches	Wall Bearing Inches
12	55.0	$5\frac{39}{64}$	$\frac{13}{16}$	3	$9\frac{1}{4}$	$1\frac{3}{8}$	$\frac{21}{32}$	$\frac{3}{4}$	12
	50.0	$5\frac{31}{64}$	$\frac{11}{16}$	3	$9\frac{1}{4}$	$1\frac{3}{8}$	$\frac{21}{32}$	$\frac{3}{4}$	
	45.0	$5\frac{23}{64}$	$\frac{9}{16}$	3	$9\frac{1}{4}$	$1\frac{3}{8}$	$\frac{21}{32}$	$\frac{3}{4}$	
	40.0	$5\frac{1}{4}$	$\frac{29}{64}$	3	$9\frac{1}{4}$	$1\frac{3}{8}$	$\frac{21}{32}$	$\frac{3}{4}$	
	35.0	$5\frac{3}{32}$	$\frac{7}{16}$	$2\frac{3}{4}$	$9\frac{3}{4}$	$1\frac{1}{8}$	$\frac{17}{32}$	$\frac{3}{4}$	
	31.5	5	$\frac{11}{32}$	$2\frac{3}{4}$	$9\frac{3}{4}$	$1\frac{1}{8}$	$\frac{17}{32}$	$\frac{3}{4}$	
10	40.0	$5\frac{3}{32}$	$\frac{3}{4}$	$2\frac{5}{8}$	8	1	$\frac{15}{32}$	$\frac{3}{4}$	8
	35.0	$4\frac{61}{64}$	$\frac{39}{64}$	$2\frac{5}{8}$	8	1	$\frac{15}{32}$	$\frac{3}{4}$	
	30.0	$4\frac{13}{16}$	$\frac{15}{32}$	$2\frac{5}{8}$	8	1	$\frac{15}{32}$	$\frac{3}{4}$	
	25.0	$4\frac{21}{32}$	$\frac{5}{16}$	$2\frac{5}{8}$	8	1	$\frac{15}{32}$	$\frac{3}{4}$	
9	35.0	$4\frac{49}{64}$	$\frac{47}{64}$	$2\frac{1}{2}$	7	1	$\frac{7}{16}$	$\frac{3}{4}$	8
	30.0	$4\frac{39}{64}$	$\frac{37}{64}$	$2\frac{1}{2}$	7	1	$\frac{7}{16}$	$\frac{3}{4}$	
	25.0	$4\frac{29}{64}$	$\frac{27}{64}$	$2\frac{1}{2}$	7	1	$\frac{7}{16}$	$\frac{3}{4}$	
	21.0	$4\frac{21}{64}$	$\frac{19}{64}$	$2\frac{1}{2}$	7	1	$\frac{7}{16}$	$\frac{3}{4}$	
8	25.5	$4\frac{17}{64}$	$\frac{17}{32}$	$2\frac{1}{4}$	$6\frac{1}{4}$	$\frac{7}{8}$	$\frac{13}{32}$	$\frac{3}{4}$	8
	23.0	$4\frac{11}{64}$	$\frac{7}{16}$	$2\frac{1}{4}$	$6\frac{1}{4}$	$\frac{7}{8}$	$\frac{13}{32}$	$\frac{3}{4}$	
	20.5	$4\frac{3}{32}$	$\frac{23}{64}$	$2\frac{1}{4}$	$6\frac{1}{4}$	$\frac{7}{8}$	$\frac{13}{32}$	$\frac{3}{4}$	
	18.0	4	$\frac{17}{64}$	$2\frac{1}{4}$	$6\frac{1}{4}$	$\frac{7}{8}$	$\frac{13}{32}$	$\frac{3}{4}$	
7	20.0	$3\frac{7}{8}$	$\frac{15}{32}$	$2\frac{1}{4}$	$5\frac{1}{4}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{5}{8}$	8
	17.5	$3\frac{49}{64}$	$\frac{23}{64}$	$2\frac{1}{4}$	$5\frac{1}{4}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{5}{8}$	
	15.0	$3\frac{21}{32}$	$\frac{1}{4}$	$2\frac{1}{4}$	$5\frac{1}{4}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{5}{8}$	
6	17.25	$3\frac{37}{64}$	$\frac{31}{64}$	2	$4\frac{1}{2}$	$\frac{3}{4}$	$\frac{11}{32}$	$\frac{5}{8}$	6
	14.75	$3\frac{29}{64}$	$\frac{23}{64}$	2	$4\frac{1}{2}$	$\frac{3}{4}$	$\frac{11}{32}$	$\frac{5}{8}$	
	12.25	$3\frac{21}{64}$	$\frac{15}{64}$	2	$4\frac{1}{2}$	$\frac{3}{4}$	$\frac{11}{32}$	$\frac{5}{8}$	
5	14.75	$3\frac{19}{64}$	$\frac{1}{2}$	$1\frac{3}{4}$	$3\frac{1}{2}$	$\frac{3}{4}$	$\frac{5}{16}$	$\frac{1}{2}$	6
	12.25	$3\frac{9}{64}$	$\frac{11}{32}$	$1\frac{3}{4}$	$3\frac{1}{2}$	$\frac{3}{4}$	$\frac{5}{16}$	$\frac{1}{2}$	
	9.75	*3*	$\frac{13}{64}$	$1\frac{3}{4}$	$3\frac{1}{2}$	$\frac{3}{4}$	$\frac{5}{16}$	$\frac{1}{2}$	

CARNEGIE STANDARDS



STANDARD FRAMING	Dist. B Inches	Dist. C Inches	Weight per Foot Pounds	Depth of Beam Inches
	5 13/16	½	55.0	12
	5 11/16	7/16	50.0	
	5 9/16	⅜	45.0	
	5½	5/16	40.0	
	5 7/16	5/16	35.0	
	5⅜	¼	31.5	
2—Ls 6" x 4" x 7/16" x 0'—7½"	5¾	7/16	40.0	10
Wt. 23 lbs.	5⅝	⅜	35.0	
	5½	5/16	30.0	
	5 5/16	¼	25.0	
	5¾	7/16	35.0	9
	5 9/16	⅜	30.0	
	5 7/16	5/16	25.0	
	5 5/16	¼	21.0	
	5 9/16	⅜	25.5	8
	5 7/16	5/16	23.0	
	5⅜	¼	20.5	
2—Ls 6" x 4" x 7/16" x 0'—5" Wt. 16 lbs.	5 5/16	3/16	18.0	
	5½	5/16	20.0	7
	5⅜	¼	17.5	
	5¼	3/16	15.0	
	5½	5/16	17.25	6
	5⅜	¼	14.75	
2—Ls 6" x 4" x 7/16" x 0'—8" for 6"	5¼	3/16	12.25	
Wt. 9 lbs.	5½	5/16	14.75	5
—Ls 6" x 4" x 7/16" x 0'—2½" for 5"	5⅜	¼	12.25	
Wt. 8 lbs.	5¼	3/16	9.75	

CARNEGIE STANDARDS

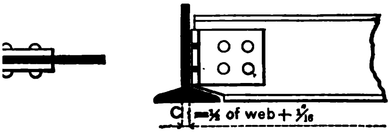
Depth of Beam Inches	Weight per Foot, Pounds	Flange Inches	Web Inches	Gauge A Inches	Tangt, t Inches	Dist, k Inches	Grip G Inches	Max. Rivet or Bolt, Inches	Wall Bearing Inches
4	10.5	$2\frac{7}{8}$	$\frac{13}{32}$	$1\frac{1}{2}$	$2\frac{3}{4}$	$\frac{5}{8}$	$\frac{9}{32}$	$\frac{1}{2}$	6
	9.5	$2\frac{13}{16}$	$\frac{11}{32}$	$1\frac{1}{2}$	$2\frac{3}{4}$	$\frac{5}{8}$	$\frac{9}{32}$	$\frac{1}{2}$	
	8.5	$2\frac{47}{64}$	$\frac{17}{64}$	$1\frac{1}{2}$	$2\frac{3}{4}$	$\frac{5}{8}$	$\frac{9}{32}$	$\frac{1}{2}$	
	7.5	$2\frac{21}{32}$	$\frac{3}{16}$	$1\frac{1}{2}$	$2\frac{3}{4}$	$\frac{5}{8}$	$\frac{9}{32}$	$\frac{1}{2}$	
3	7.5	$2\frac{33}{64}$	$\frac{23}{64}$	$1\frac{7}{16}$	$1\frac{3}{4}$	$\frac{5}{8}$	$\frac{1}{4}$	$\frac{3}{8}$	6
	6.5	$2\frac{27}{64}$	$\frac{17}{64}$	$1\frac{7}{16}$	$1\frac{3}{4}$	$\frac{5}{8}$	$\frac{1}{4}$	$\frac{3}{8}$	
	5.5	$2\frac{21}{64}$	$\frac{11}{64}$	$1\frac{7}{16}$	$1\frac{3}{4}$	$\frac{5}{8}$	$\frac{1}{4}$	$\frac{3}{8}$	

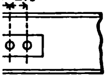
When beams frame opposite each other into another beam thickness less than $\frac{5}{16}$ in., or where beams of short span length a to their full capacity, it may be necessary to use framing greater strength than the standards.

TABLE FOR MINIMUM SPAN LENGTHS

Depth of Beam	Weight	Span in Feet	Depth of Beam	Weight	Span in Feet	Depth of Beam	Weight
24	80.0	22.0	....	....	....	15	80.0
20	80.0	22.0	18	55.0	14.5	15	60.0
20	65.0	18.0	....	....	....	15	42.0

ARNEGIE STANDARDS



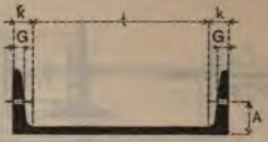
RAMING	Dist. B Inches	Dist. C Inches	Weight per Foot, Pounds	Depth of Beam Inches
	$5\frac{7}{16}$	$\frac{5}{16}$	10.5	4
l 3″	$5\frac{3}{8}$	$\frac{1}{4}$	9.5	
″2¼″	$5\frac{1}{4}$	$\frac{3}{16}$	8.5	
	$5\frac{3}{16}$	$\frac{3}{16}$	7.5	
	$5\frac{3}{8}$	$\frac{1}{4}$	7.5	3
⅞″ x 0′—8″ lbs.	$5\frac{1}{4}$	$\frac{3}{16}$	6.5	
	$5\frac{3}{16}$	$\frac{3}{16}$	5.5	

ıdard framing angles are ¾ in. diameter.
dard framing angles include weight of shop and

FOR MINIMUM SPAN LENGTHS

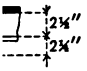
Beam	Weight	Span in Feet	Depth of Beam	Weight	Span in Feet	Depth of Beam	Weight	Span in Feet
..	....	....	8	18.0	5.5	5	9.75	4.0
10	25.0	9.5	7	15.0	4.0	4	7.5	3.0
9	21.0	7.0	6	12.25	3.5	3	5.5	2.0

CARNEGIE STANDARDS



Depth of Chan. Inches	Weight per Foot, Pounds	Flange Inches	Web Inches	Gauge A Inches	Tangt. t Inches	Dist. k Inches	Grip G Inches	Max. Rivet or Bolt, Inches
15	55.00	$3\frac{13}{16}$	$\frac{13}{16}$	$2\frac{1}{4}$	$12\frac{1}{4}$	$1\frac{3}{8}$	$\frac{5}{8}$	$\frac{3}{4}$
	50.00	$3\frac{23}{32}$	$\frac{23}{32}$	$2\frac{1}{4}$	$12\frac{1}{4}$	$1\frac{3}{8}$	$\frac{5}{8}$	$\frac{3}{4}$
	45.00	$3\frac{5}{8}$	$\frac{5}{8}$	$2\frac{1}{4}$	$12\frac{1}{4}$	$1\frac{3}{8}$	$\frac{5}{8}$	$\frac{3}{4}$
	40.00	$3\frac{17}{32}$	$\frac{17}{32}$	$1\frac{7}{8}$	$12\frac{1}{4}$	$1\frac{3}{8}$	$\frac{21}{32}$	$\frac{3}{4}$
	35.00	$3\frac{27}{64}$	$\frac{27}{64}$	$1\frac{7}{8}$	$12\frac{1}{4}$	$1\frac{3}{8}$	$\frac{21}{32}$	$\frac{3}{4}$
	33.00	$3\frac{13}{32}$	$\frac{13}{32}$	$1\frac{7}{8}$	$12\frac{1}{4}$	$1\frac{3}{8}$	$\frac{21}{32}$	$\frac{3}{4}$
12	40.00	$3\frac{27}{64}$	$\frac{49}{64}$	2	10	1	$\frac{15}{32}$	$\frac{3}{4}$
	35.00	$3\frac{19}{64}$	$\frac{41}{64}$	2	10	1	$\frac{15}{32}$	$\frac{3}{4}$
	30.00	$3\frac{11}{64}$	$\frac{33}{64}$	2	10	1	$\frac{15}{32}$	$\frac{3}{4}$
	25.00	$3\frac{3}{64}$	$\frac{25}{64}$	$1\frac{3}{4}$	10	1	$\frac{15}{32}$	$\frac{3}{4}$
	20.50	$2\frac{15}{16}$	$\frac{9}{32}$	$1\frac{3}{4}$	10	1	$\frac{15}{32}$	$\frac{3}{4}$
10	35.00	$3\frac{3}{16}$	$\frac{53}{64}$	2	$8\frac{1}{4}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{3}{4}$
	30.00	$3\frac{1}{32}$	$\frac{43}{64}$	2	$8\frac{1}{4}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{3}{4}$
	25.00	$2\frac{57}{64}$	$\frac{17}{32}$	2	$8\frac{1}{4}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{3}{4}$
	20.00	$2\frac{47}{64}$	$\frac{3}{8}$	$1\frac{1}{2}$	$8\frac{1}{4}$	$\frac{7}{8}$	$\frac{7}{16}$	$\frac{3}{4}$
	15.00	$2\frac{19}{32}$	$\frac{15}{64}$	$1\frac{1}{2}$	$8\frac{1}{4}$	$\frac{7}{8}$	$\frac{7}{16}$	$\frac{3}{4}$
9	25.00	$2\frac{13}{16}$	$\frac{39}{64}$	$1\frac{3}{4}$	$7\frac{1}{4}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{3}{4}$
	20.00	$2\frac{21}{32}$	$\frac{29}{64}$	$1\frac{3}{4}$	$7\frac{1}{4}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{3}{4}$
	15.00	$2\frac{31}{64}$	$\frac{9}{32}$	$1\frac{3}{8}$	$7\frac{1}{4}$	$\frac{7}{8}$	$\frac{13}{32}$	$\frac{3}{4}$
	13.25	$2\frac{7}{16}$	$\frac{15}{64}$	$1\frac{3}{8}$	$7\frac{1}{4}$	$\frac{7}{8}$	$\frac{13}{32}$	$\frac{3}{4}$
8	21.25	$2\frac{5}{8}$	$\frac{37}{64}$	$1\frac{1}{2}$	$6\frac{1}{4}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{3}{4}$
	18.75	$2\frac{17}{32}$	$\frac{31}{64}$	$1\frac{1}{2}$	$6\frac{1}{4}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{3}{4}$
	16.25	$2\frac{7}{16}$	$\frac{25}{64}$	$1\frac{1}{2}$	$6\frac{1}{4}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{3}{4}$
	13.75	$2\frac{11}{32}$	$\frac{19}{64}$	$1\frac{1}{4}$	$6\frac{1}{4}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{3}{4}$
	11.25	$2\frac{17}{64}$	$\frac{7}{32}$	$1\frac{1}{4}$	$6\frac{1}{4}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{3}{4}$

CARNEGIE STANDARDS



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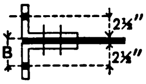
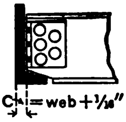
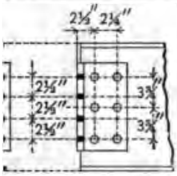
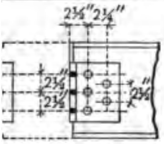
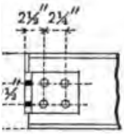
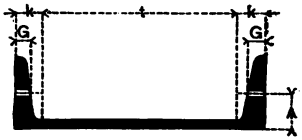
standards





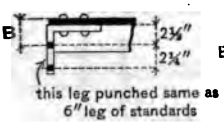
'RAMING	Dist. B Inches	Dist. C Inches	Weight per Foot Pounds	Depth of Chan. Inches
	3 5/16	7/8	55.00	
	3 1/4	13/16	50.00	
	3 1/8	11/16	45.00	15
	3	5/8	40.00	
	2 15/16	1/2	35.00	
	2 7/8	1/2	33.00	
	3 1/4	13/16	40.00	
	3 1/8	11/16	35.00	
	3	9/16	30.00	12
	2 7/8	7/16	25.00	
	2 13/16	3/8	20.50	
x 7/16" x 0'—7½"	3 5/16	7/8	35.00	
. 23 lbs.	3 3/16	3/4	30.00	
	3	5/8	25.00	10
	2 7/8	7/16	20.00	
	2 3/4	5/16	15.00	
and 10"	3 1/8	11/16	25.00	
	3	1/2	20.00	9
	2 13/16	3/8	15.00	
	2 3/4	5/16	13.25	
	3 1/16	5/8	21.25	
" x 7/16" x 0'—5"	3	9/16	18.75	
. 16 lbs.	2 7/8	7/16	16.25	8
	2 13/16	3/8	13.75	
	2 3/4	5/16	11.25	

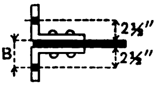
CARNEGIE STANDARDS

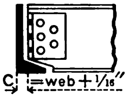


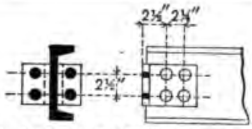
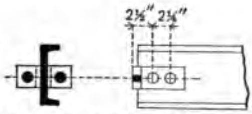
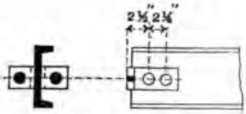
Depth of Chan. Inches	Weight per Foot, Pounds	Flange Inches	Web Inches	Gauge A Inches	Tangt. t Inches	Dist. k Inches	Grip G Inches
	19.75	$2\frac{33}{64}$	$\frac{5}{8}$	$1\frac{1}{2}$	$5\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{8}$
	17.25	$2\frac{13}{32}$	$\frac{33}{64}$	$1\frac{1}{2}$	$5\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{8}$
7	14.75	$2\frac{19}{64}$	$\frac{13}{32}$	$1\frac{1}{4}$	$5\frac{1}{2}$	$\frac{3}{4}$	$\frac{11}{32}$
	12.25	$2\frac{13}{64}$	$\frac{5}{16}$	$1\frac{1}{4}$	$5\frac{1}{2}$	$\frac{3}{4}$	$\frac{11}{32}$
	9.75	$2\frac{3}{32}$	$\frac{13}{64}$	$1\frac{1}{4}$	$5\frac{1}{2}$	$\frac{3}{4}$	$\frac{11}{32}$
	15.50	$2\frac{9}{32}$	$\frac{9}{16}$	$1\frac{3}{8}$	$4\frac{1}{2}$	$\frac{3}{4}$	$\frac{11}{32}$
6	13.00	$2\frac{5}{32}$	$\frac{7}{16}$	$1\frac{3}{8}$	$4\frac{1}{2}$	$\frac{3}{4}$	$\frac{11}{32}$
	10.50	$2\frac{1}{32}$	$\frac{5}{16}$	$1\frac{1}{8}$	$4\frac{1}{2}$	$\frac{3}{4}$	$\frac{11}{32}$
	8.00	$1\frac{59}{64}$	$\frac{13}{64}$	$1\frac{1}{8}$	$4\frac{1}{2}$	$\frac{3}{4}$	$\frac{11}{32}$
	11.50	$2\frac{1}{32}$	$\frac{15}{32}$	$1\frac{1}{4}$	$3\frac{3}{4}$	$\frac{5}{8}$	$\frac{5}{16}$
5	9.00	$1\frac{57}{64}$	$\frac{21}{64}$	$1\frac{1}{4}$	$3\frac{3}{4}$	$\frac{5}{8}$	$\frac{5}{16}$
	6.50	$1\frac{3}{4}$	$\frac{3}{16}$	1	$3\frac{3}{4}$	$\frac{5}{8}$	$\frac{5}{16}$
	7.25	$1\frac{23}{32}$	$\frac{21}{64}$	1	$2\frac{3}{4}$	$\frac{5}{8}$	$\frac{9}{32}$
4	6.25	$1\frac{21}{32}$	$\frac{17}{64}$	1	$2\frac{3}{4}$	$\frac{5}{8}$	$\frac{9}{32}$
	5.25	$1\frac{37}{64}$	$\frac{3}{16}$	1	$2\frac{3}{4}$	$\frac{5}{8}$	$\frac{9}{32}$
	6.00	$1\frac{39}{64}$	$\frac{3}{8}$	$\frac{15}{16}$	$1\frac{3}{4}$	$\frac{5}{8}$	$\frac{1}{4}$
3	5.00	$1\frac{1}{2}$	$\frac{17}{64}$	$\frac{15}{16}$	$1\frac{3}{4}$	$\frac{5}{8}$	$\frac{1}{4}$
	4.00	$1\frac{13}{32}$	$\frac{11}{64}$	$\frac{15}{16}$	$1\frac{3}{4}$	$\frac{5}{8}$	$\frac{1}{4}$

CARNEGIE STANDARDS

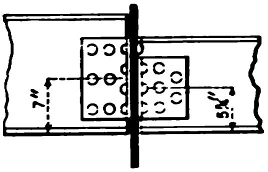




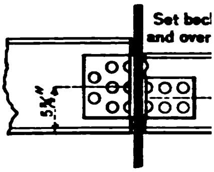


STANDARD FRAMING	Dist. B Inches	Dist. C Inches	Weight per Foot Pounds	Depth of Chan. Inches
"  2—Ls 6" x 4" x 7/16" x 0'—5" Wt. 16 lbs.	3⅛	11/16	19.75	7
	3	9/16	17.25	
	2 15/16	½	14.75	
	2 13/16	⅜	12.25	
	2 11/16	¼	9.75	
ınd 5"  2—Ls 6" x 4" x 7/16" x 0'—3" for 6" Wt. 9 lbs. 2—Ls 6" x 4" x 7/16" x 0'—2½" for 5" Wt. 8 lbs.	3 1/16	⅝	15.50	6
	2 15/16	½	13.00	
	2 13/16	⅜	10.50	
	2 11/16	¼	8.00	
	3	9/16	11.50	5
	2 13/16	⅜	9.00	
	2 11/16	¼	6.50	
and 3"  2—Ls 6" x 4" x 7/16" x 0'—2" Wt. 7 lbs.	2 13/16	⅜	7.25	4
	2¾	5/16	6.25	
	2 11/16	¼	5.25	
	2⅞	7/16	6.00	3
	2¾	5/16	5.00	
	2 11/16	¼	4.00	

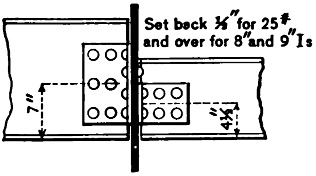
CONNECTIONS FOR DIFFERENT DEPT
BEAMS FRAMING OPPOSITE



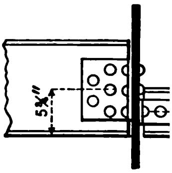
15" AND 12"



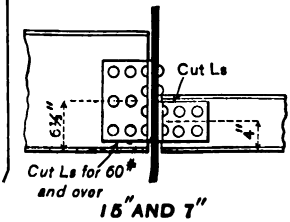
12" AND 10"
12" AND 9"
12" AND 8"



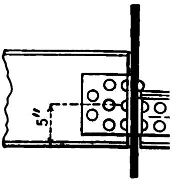
15" AND 10"
15" AND 9"
15" AND 8"



12" AND

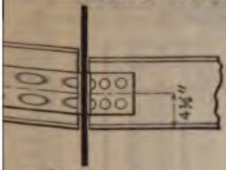


15" AND 7"

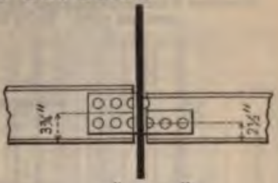


12" AND

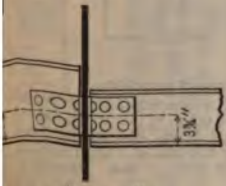
TIONS FOR DIFFERENT DEPTHS OF BEAMS FRAMING OPPOSITE



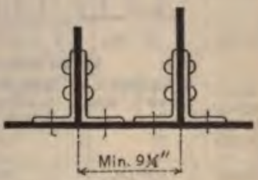
10″ AND 9″
10″ AND 8″
9″ AND 8″

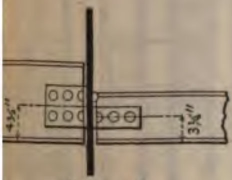


7″ AND 6″

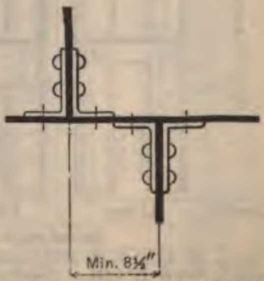


10″ AND 7″
9″ AND 7″
8″ AND 7″





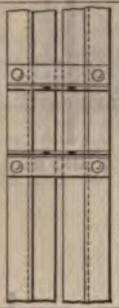
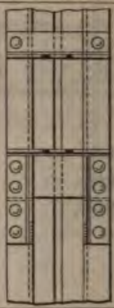
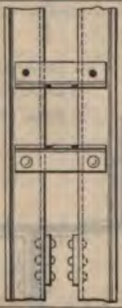
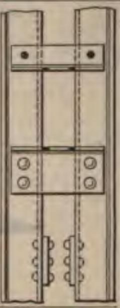
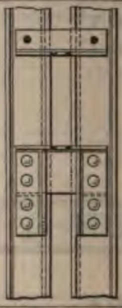
10″ AND 6″
9″ AND 6″
8″ AND 6″



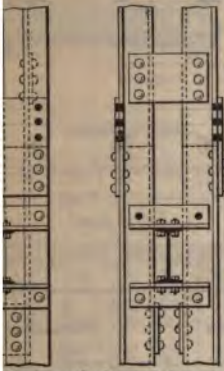
standard gauge (2½ in.) connection Ls on beam with lightest The first *hole in connection* Ls is ¾ in. from bottom of beam in all *xcept when a 7 in.* beam frames opposite, in which case the con- *is special.*

CONNECTIONS FOR CONSTANT DIME
Z-BAR COLUMNS

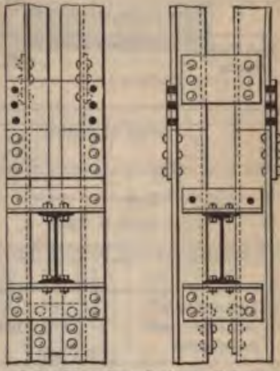
The number of tons indicated denote the end reactions of load on beams for colun metal and above. For ¼ in. metal reduce them by 15 per cent.

Sketch of Connections				
Reaction	4.4 Tons	8.8 Tons	17.7 Tons	
	Size and weight of material used for connections			
Bill of Material for one Connt'n	2Ls 3½x3x⅜ 1′—1″ 4 rivets ¾″ diam.	1L 3½x3x3⅜ 1′—1″ 1L 6x3½x⅜ 1′—1″ 6 rivets ¾″ diam.	1L 3½x3x⅜ 1′—1″ 1L 6x3½x⅜ 1′—1″ 2Ls 3x3x⅜ 0′—11⅝″ 2 Fills 3x⅜ 0′—5¾″ 10 rivets ¾″ diam.	1L 3½ 1L 6x3 2Ls 3x 2 Fills 14 rive
Weight	19 lbs.	24 lbs.	44 lbs.	
Sketch of Connections				
Reaction	4.4 Tons	8.8 Tons	17.7 Tons	
	Size and weight of material used for connections			
Bill of Material for one Connt'n	2Ls 3½x3x⅜ 0′—11″ 4 rivets ¾″ diam.	1L 3½x3x⅜ 0′—11″ 1L 6x3½x⅜ 0′—11″ 6 rivets ¾″ diam.	1L 3½x3x⅜ 0′—11″ 1L 6x3½x⅜ 0′—11″ 2Ls 3x3x⅜ 0′—11⅝″ 2 Fills 3x⅜ 0′—5¾″ 10 rivets ¾″ diam.	1L 3½ 1L 6x3 2Ls 6x 2 Fills 17 rive
Weight	16 lbs.	21 lbs.	40 lbs.	

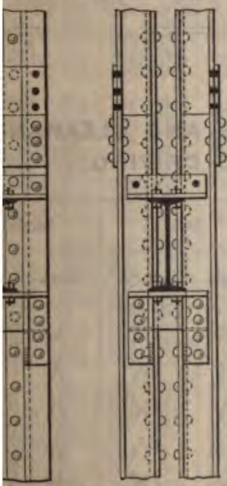
ILS OF SPLICES AND CONNECTIONS FOR I-BEAMS TO CONSTANT DIMENSION Z-BAR COLUMNS



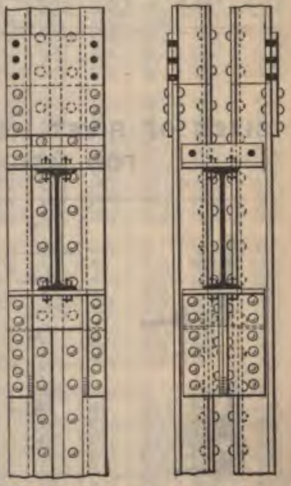
Metal and above 4.4 tons



$\frac{5}{16}$ in. Metal and above 8.8 tons



Metal and above 17.7 tons



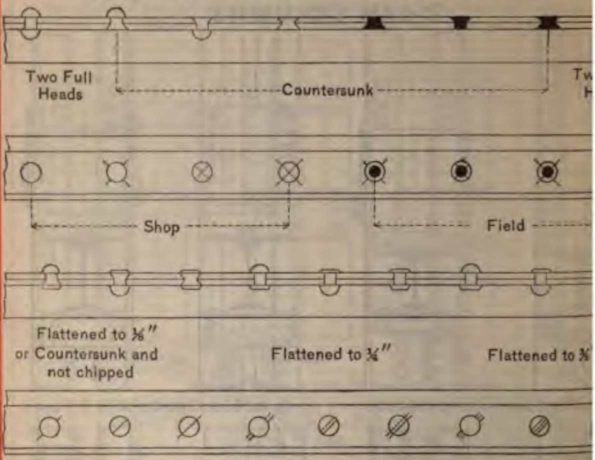
$\frac{7}{16}$ in. Metal and above 26.5 tons

r description of *other details* see page 136

ets and bolts ¾ in. diameter

ce plates 18 in. by thickness of Zs by 1 ft. 6 in. long

CONVENTIONAL SIGNS FOR RIVETING

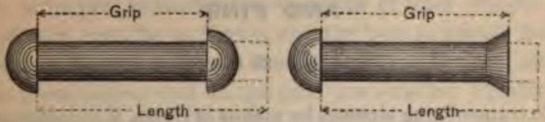


SIZES OF RIVET HEADS AND CLEARANC FOR MACHINE DRIVING

Size	Head		Countersur
Diam.	Height	Diam. "H"	Depth
½	⅜	⅞	¼
⅝	$\frac{15}{32}$	$1\frac{1}{16}$	$\frac{5}{16}$
¾	$\frac{9}{16}$	1¼	⅜
⅞	$\frac{21}{32}$	$1\frac{7}{16}$	$\frac{7}{16}$
1	¾	1⅝	½

A must not be less than ¼ in. + ½ H.

LENGTHS OF RIVETS FOR VARIANT GRIPS



Grip in Inches	Diameter in Inches					Diameter in Inches					Grip in Inches
	½	⅝	¾	⅞	1	½	⅝	¾	⅞	1	
	Length in Inches					Length in Inches					
½	1½	1¾	1⅞	2	2⅛	1⅛	1¼	1¼	1⅜	1⅜	½
⅝	1⅝	1⅞	2	2⅛	2¼	1¼	1⅜	1⅜	1½	1½	⅝
¾	1¾	2	2⅛	2¼	2⅜	1⅜	1½	1½	1⅝	1⅝	¾
⅞	1⅞	2⅛	2¼	2⅜	2½	1½	1⅝	1⅝	1¾	1¾	⅞
1	2	2¼	2⅜	2½	2⅝	1⅝	1¾	1¾	1⅞	1⅞	1
1⅛	2⅛	2⅜	2½	2⅝	2¾	1¾	1⅞	1⅞	2	2	1⅛
1¼	2¼	2½	2⅝	2¾	2⅞	1⅞	2	2	2⅛	2⅛	1¼
1⅜	2⅜	2⅝	2¾	2⅞	3	2	2⅛	2⅛	2¼	2¼	1⅜
1½	2⅝	2⅞	3	3⅛	3¼	2⅛	2¼	2⅜	2⅜	2½	1½
1⅝	2¾	3	3⅛	3¼	3⅜	2¼	2⅜	2½	2½	2⅝	1⅝
1¾	2⅞	3⅛	3¼	3⅜	3½	2⅜	2½	2⅝	2⅝	2¾	1¾
1⅞	3	3¼	3⅜	3½	3⅝	2½	2⅝	2¾	2¾	2⅞	1⅞
2	3⅛	3⅜	3½	3⅝	3¾	2⅝	2¾	2⅞	2⅞	3	2
2⅛	3¼	3½	3⅝	3¾	3⅞	2¾	2⅞	3	3	3⅛	2⅛
2¼	3⅜	3⅝	3¾	3⅞	4	2⅞	3	3⅛	3⅛	3¼	2¼
2⅜	3½	3¾	3⅞	4	4⅛	3	3⅛	3¼	3¼	3⅜	2⅜
2½	3⅝	3⅞	4	4⅛	4¼	3⅛	3¼	3⅜	3⅜	3½	2½
2⅝	3¾	4	4⅛	4¼	4⅜	3¼	3⅜	3½	3½	3⅝	2⅝
2¾	3⅞	4⅛	4¼	4⅜	4½	3⅜	3½	3⅝	3⅝	3¾	2¾
2⅞	4	4¼	4⅜	4½	4⅝	3½	3⅝	3¾	3¾	3⅞	2⅞
3	4¼	4½	4⅝	4¾	4⅞	3¾	3⅞	3⅞	4	4⅛	3
3⅛	4⅜	4⅝	4¾	4⅞	5	3⅞	4	4	4⅛	4¼	3⅛
3¼	4½	4¾	4⅞	5	5⅛	4	4⅛	4⅛	4¼	4⅜	3¼
3⅜	4⅝	4⅞	5	5⅛	5¼	4⅛	4¼	4¼	4⅜	4½	3⅜
3½	4¾	5	5⅛	5¼	5⅜	4¼	4⅜	4⅜	4½	4⅝	3½
3⅝	4⅞	5⅛	5¼	5⅜	5½	4⅜	4½	4½	4⅝	4¾	3⅝
3¾	5	5¼	5⅜	5½	5⅝	4½	4⅝	4⅝	4¾	4⅞	3¾
3⅞	5⅛	5⅜	5½	5⅝	5¾	4⅝	4¾	4¾	4⅞	5	3⅞
4	5¼	5½	5⅝	5¾	5⅞	4¾	4⅞	4⅞	5	5⅛	4
4⅛	5⅜	5⅝	5¾	5⅞	6	4⅞	5	5	5⅛	5¼	4⅛
4¼	5½	5¾	5⅞	6	6⅛	5	5⅛	5⅛	5¼	5⅜	4¼
4⅜	5⅝	5⅞	6	6⅛	6¼	5⅛	5¼	5¼	5⅜	5½	4⅜
4½	5¾	6	6¼	6⅜	6½	5¼	5⅜	5½	5½	5⅝	4½
4⅝	6	6¼	6⅜	6½	6⅝	5½	5⅝	5⅝	5⅝	5¾	4⅝
4¾	6⅛	6⅜	6½	6⅝	6¾	5⅝	5¾	5¾	5¾	5⅞	4¾
4⅞	6¼	6½	6⅝	6¾	6⅞	5¾	5⅞	5⅞	5⅞	6	4⅞
5	6⅜	6⅝	6¾	6⅞	7	5⅞	6	6	6	6⅛	5

EXPLANATION OF TABLES ON RIVETS AND PINS

Pages 195 to 199 Inclusive

In transmitting stresses by means of rivets, it is customary to disregard the friction between the parts joined, as too uncertain an element to be relied upon to any extent. The rivets must then be proportioned for the entire stress which is to be transmitted from one plate or group of plates to the other, and they must be of sufficient size and number to present ample resistance to shearing and afford sufficient bearing area so as not to cause a crushing of the metal at the rivet holes. This latter condition, while generally observed for pins, is very often entirely overlooked in riveted work. Its observance, in most cases of riveted girders with single webs, determines the size and number of rivets to be used and frequently makes it necessary to adopt a greater thickness of web than would otherwise be required. Thus, if the web is $\frac{5}{16}$ in. thick, the rivets connecting the same with the flange angles have a bearing value of only 3,520 lbs. for a ¾ in. rivet, while their shearing value is $= 2 \times 3{,}310 = 6{,}620$ lbs. per rivet, the rivets being in double shear. Consequently, while the usual thickness of web of floor beams for railway bridges is ⅜ in., it sometimes becomes necessary for shallow floor beams to increase this thickness to ½ in. and even ⅝ in., in order that the pressure of the rivets upon the semi-intrados of the rivet holes be not excessive between the points of support of floor beam and of application of the load (in which space the transmission of strain from web to flanges takes place).

Pins must be calculated for shearing, bending and bearing stresses, but one of the latter two only in almost every case determines the size to be used. The stress allowed upon *pin-bearing* in bridges proportioned to a factor of safety of five is *usually 12,000* lbs. and the maximum fiber stress by bending

lbs. per square inch. When groups of bars are connected
: same pin, as in the lower chords of truss bridges, the
of bars must be so chosen and the bars so placed that at
int on the pin will there be an excessive bending stress,
e presumption that all the bars are strained equally per
e inch.

'he following is the formula for flexure applied to pins:

$$M = \frac{f \pi d^3}{32} \text{ or } = \frac{f A d}{8}.$$

M = moment of forces for any section through pin.

f = stress per square inch in extreme fibers of pin at that section.

A = area of section; d = diameter; $\pi = 3.14159$.

The forces are assumed to act in a plane passing through
xis of the pin.

The tables on pages 197 and 198 give the values of M for
rent diameters of pin and for different values of f.

The following examples will illustrate the use of the tables:

. A pin in the bolster or end shoe of a bridge has to carry
d of 40,000 lbs. between two points of support; what size
n is required, assuming the distance between points (*i. e.*,
rs) of support of bolster plates and centers of pressure of
post plates = 2½ in.?

Answer: Bending moments = 20,000 lbs. × 2½ = 50,000 inch
therefore, 3¼ in. pin required for 15,000 lbs. fiber stress,
the allowed moment for 3¼ in. = 50,600 as per table.

. Required the thickness of metal in the top chord or in a
of a bridge that will give sufficient bearing area to a 3⅜ in.
having to transmit a stress of 60,700 lbs.; the allowed pres-
per square inch on bearing being 12,000 lbs. maximum.

The bearing value of a 3⅜ in. pin for 1 in. thickness of plate =
0 lbs., therefore, the thickness of metal required = $\frac{60,700}{40,500}$ =
n., or each of the two plates in the chord or post will have
¾ in. thick.

SHEARING AND BEARING VALUE OF RIVETS

ALL DIMENSIONS IN INCHES

Diameter of Rivet, Inches: Fraction	Diameter of Rivet, Inches: Decimal	Area in Square Inches	Single Shear at 6,000 lbs.	Bearing Value For ¼	Bearing Value For $\frac{5}{16}$	Bearing Value For ⅜	Bearing Value For $\frac{7}{16}$
⅜	.375	.1104	660	1130	1410	1690	
½	.500	.1963	1180	1500	1880	2250	2620
⅝	.625	.3068	1840	1880	2340	2810	3280
¾	.750	.4418	2650	2250	2810	3380	3940
⅞	.875	.6013	3610	2630	3280	3940	4590
1	1.000	.7854	4710	3000	3750	4500	5250

Diameter of Rivet, Inches: Fraction	Diameter of Rivet, Inches: Decimal	Area in Square Inches	Single Shear at 7,500 lbs.	Bearing Value For ¼	Bearing Value For $\frac{5}{16}$	Bearing Value For ⅜	Bearing Value For $\frac{7}{16}$
⅜	.375	.1104	830	1410	1760	2110	
½	.500	.1963	1470	1880	2340	2810	3280
⅝	.625	.3068	2300	2340	2930	3520	4100
¾	.750	.4418	3310	2810	3520	4220	4920
⅞	.875	.6013	4510	3280	4100	4920	5740
1	1.000	.7854	5890	3750	4690	5620	6560

Diameter of Rivet, Inches: Fraction	Diameter of Rivet, Inches: Decimal	Area in Square Inches	Single Shear at 10,000 lbs.	Bearing Value For ¼	Bearing Value For $\frac{5}{16}$	Bearing Value For ⅜	Bearing Value For $\frac{7}{16}$
⅜	.375	.1104	1100	1880	2340	2810	
½	.500	.1963	1960	2500	3130	3750	4380
⅝	.625	.3068	3070	3130	3910	4690	5470
¾	.750	.4418	4420	3750	4690	5630	6560
⅞	.875	.6013	6010	4380	5470	6570	7660
1	1.000	.7854	7850	5000	6250	7500	8750

Diameter of Rivet, Inches: Fraction	Diameter of Rivet, Inches: Decimal	Area in Square Inches	Single Shear at 12,000 lbs.	Bearing Value For ¼	Bearing Value For $\frac{5}{16}$	Bearing Value For ⅜	Bearing Value For $\frac{7}{16}$
⅜	.375	.1104	1320	2350	2930	3520	
½	.500	.1963	2360	3130	3910	4690	5470
⅝	.625	.3068	3680	3910	4880	5860	6840
¾	.750	.4418	5300	4690	5860	7030	8210
⅞	.875	.6013	7220	5470	6840	8210	9580
1	1.000	.7854	9430	6250	7820	9380	10940

In above tables all bearing values above or to right of upper zigzag lines are greater than double shear. Values between upper and lower zigzag lines are less than double and greater than single shear.

HEARING AND BEARING VALUE OF RIVETS

ALL DIMENSIONS IN INCHES

Different Thicknesses of Plate in Inches at 12,000 lbs. per Square Inch

9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
4220	4690	....	....	....	....	....	....
5060	5630	6190	6750	....	....	....	....
5910	6560	7220	7880	8530	9190	9840	....
6750	7500	8250	9000	9750	10500	11250	12000

Different Thicknesses of Plate in Inches at 15,000 lbs. per Square Inch

9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
5280	5860	....	....	....	....	....	....
6330	7030	7720	8440	....	....	....	....
7380	8200	9030	9850	10670	11480	12300	....
8440	9380	10310	11250	12190	13130	14060	15000

Different Thicknesses of Plate in Inches at 20,000 lbs. per Square Inch

9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
7030	7810	....	....	....	....	....	....
8440	9380	10310	11250	....	....	....	....
9840	10940	12030	13130	14220	15310	16410	....
11250	12500	13750	15000	16250	17500	18750	20000

Different Thicknesses of Plate in Inches at 25,000 lbs. per Square Inch

9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
8790	9770	....	....	....	....	....	....
10550	11720	12890	14060	....	....	....	....
12310	13670	15040	16410	17770	19140	20510	....
14060	15630	17190	18750	20320	21880	23440	25000

ues below and to left of lower zigzag lines are less than single shear.

MAXIMUM BENDING MOMENTS OF PINS
WITH EXTREME FIBER STRESSES
VARYING FROM 15,000 TO 25,000 POUNDS PER SQUARE INCH

Diameter of Pin in Inches	Area of Pin in Square Inches	Moments in Inch-Pounds for Fiber Stresses of				
		15,000 lbs. per Square Inch	18,000 lbs. per Square Inch	20,000 lbs. per Square Inch	22,500 lbs. per Square Inch	25,000 lbs. per Square Inch
1	0.785	1470	1770	1960	2210	2450
1⅛	0.994	2100	2520	2800	3140	3500
1¼	1.227	2880	3450	3830	4310	4790
1⅜	1.485	3830	4590	5100	5740	6380
1½	1.767	4970	5960	6630	7460	8280
1⅝	2.074	6320	7580	8430	9480	10500
1¾	2.405	7890	9470	10500	11800	13200
1⅞	2.761	9710	11600	12900	14600	16200
2	3.142	11800	14100	15700	17700	19600
2⅛	3.547	14100	17000	18800	21200	23600
2¼	3.976	16800	20100	22400	25200	28000
2⅜	4.430	19700	23700	26300	29600	32900
2½	4.909	23000	27600	30700	34500	38400
2⅝	5.412	26600	32000	35500	40000	44400
2¾	5.940	30600	36800	40800	45900	51000
2⅞	6.492	35000	42000	46700	52500	58300
3	7.069	39800	47700	53000	59600	66300
3⅛	7.670	44900	53900	59900	67400	74900
3¼	8.296	50600	60700	67400	75800	84300
3⅜	8.946	56600	67900	75500	84900	94400
3½	9.621	63100	75800	84200	94700	105200
3⅝	10.321	70100	84200	93500	105200	116900
3¾	11.045	77700	93200	103500	116500	129400
3⅞	11.793	85700	102800	114200	128500	142800
4	12.566	94200	113100	125700	141400	157100
4⅛	13.364	103400	124000	137800	155000	172300
4¼	14.186	113000	135700	150700	169600	188400
4⅜	15.033	123300	148000	164400	185000	205500
4½	15.904	134200	161000	178900	201300	223700
4⅝	16.800	145700	174800	194300	218500	242800
4¾	17.721	157800	189400	210400	236700	263000
4⅞	18.665	170600	204700	227500	255900	284400
5	19.635	184100	220900	245400	276100	306800
5⅛	20.629	198200	237900	264300	297300	330400
5¼	21.648	213100	255700	284100	319600	355200
5⅜	22.691	228700	274400	304900	343000	381100
5½	23.758	245000	294000	326700	367500	408300
5⅝	24.850	262100	314500	349500	393100	436800
5¾	25.967	280000	335900	373300	419900	466600
5⅞	27.109	298600	358300	398200	447900	497700

IMUM BENDING MOMENTS OF PINS
WITH EXTREME FIBER STRESSES
FROM 15,000 TO 25,000 POUNDS PER SQUARE INCH

Area of Pin in Square Inches	Moments in Inch-Pounds for Fiber Stresses of				
	15,000 lbs. per Square Inch	18,000 lbs. per Square Inch	20,000 lbs. per Square Inch	22,500 lbs. per Square Inch	25,000 lbs. per Square Inch
28.274	318100	381700	424100	477100	530200
29.465	338400	406100	451200	507600	564000
30.680	359500	431400	479400	539300	599200
31.919	381500	457800	508700	572300	635900
33.183	404400	485300	539200	606600	674000
34.472	428200	513800	570900	642300	713700
35.785	452900	543500	603900	679400	754800
37.122	478500	574200	638000	717800	797500
38.485	505100	606100	673500	757700	841900
39.871	532700	639200	710200	799000	887800
41.282	561200	673400	748200	841800	935300
42.718	590700	708900	787600	886100	984500
44.179	621300	745500	828400	931900	1035400
45.664	652900	783400	870500	979300	1088100
47.173	685500	822600	914000	1028200	1142500
48.707	719200	863000	958900	1078800	1198700
50.265	754000	904800	1005300	1131000	1256600
51.849	789900	947900	1053200	1184800	1316500
53.456	826900	992300	1102500	1240300	1378200
55.088	865100	1038100	1153400	1297600	1441800
56.745	904400	1085200	1205800	1356600	1507300
58.426	944900	1133800	1259800	1417300	1574800
60.132	986500	1183800	1315400	1479800	1644200
61.862	1029400	1235300	1372500	1544100	1715700
63.617	1073500	1288200	1431400	1610300	1789200
65.397	1118900	1342700	1491900	1678400	1864800
67.201	1165500	1398600	1554000	1748300	1942500
69.029	1213400	1456100	1617900	1820100	2022300
70.882	1262600	1515100	1683400	1893900	2104300
72.760	1313100	1575700	1750800	1969600	2188500
74.662	1364900	1637900	1819900	2047400	2274900
76.590	1418100	1701700	1890800	2127100	2363500
78.54	1472600	1767100	1963500	2208900	2454400
82.52	1585900	1903000	2114500	2378800	2643100
86.59	1704700	2045700	2273000	2557100	2841200
90.76	1829400	2195300	2439300	2744200	3049100
95.03	1960100	2352100	2613400	2940100	3266800
99.40	2096800	2516100	2795700	3145200	3494800
103.87	2239700	2687600	2986300	3359500	3732800
113.10	*2544700*	3053600	3392900	3817000	4241200

BEARING VALUES OF PINS

FOR ONE INCH THICKNESS OF PLATE

(=Diameter of Pin × 1 in. × Stress per Square Inch)

Diameter of Pin Inches	Area of Pin Square Inches	Bearing Value at 12,000 lbs. per Square Inch Pounds	Bearing Value at 15,000 lbs. per Square Inch Pounds	Diameter of Pin Inches	Area of Pin Square Inches	Bearing Value at 12,000 lbs. per Square Inch Pounds	Bearing Value at 15,000 lbs. per Square Inch Pounds
1	.785	12000	15000	4½	15.90	54000	6750
1⅛	.994	13500	16900	4⅝	16.80	55500	6940
1¼	1.227	15000	18800	4¾	17.72	57000	7130
1⅜	1.485	16500	20600	4⅞	18.67	58500	7310
1½	1.767	18000	22500	5	19.64	60000	7500
1⅝	2.074	19500	24400	5⅛	20.63	61500	7690
1¾	2.405	21000	26300	5¼	21.65	63000	7880
1⅞	2.761	22500	28100	5⅜	22.69	64500	8060
2	3.142	24000	30000	5½	23.76	66000	8250
2⅛	3.547	25500	31900	5⅝	24.85	67500	8440
2¼	3.976	27000	33800	5¾	25.97	69000	8630
2⅜	4.430	28500	35600	5⅞	27.11	70500	8810
2½	4.909	30000	37500	6	28.27	72000	9000
2⅝	5.412	31500	39400	6⅛	29.46	73500	9190
2¾	5.940	33000	41300	6¼	30.68	75000	9380
2⅞	6.492	34500	43100	6⅜	31.92	76500	9560
3	7.069	36000	45000	6½	33.18	78000	9750
3⅛	7.670	37500	46900	6⅝	34.47	79500	9940
3¼	8.296	39000	48800	6¾	35.79	81000	10130
3⅜	8.946	40500	50600	6⅞	37.12	82500	10310
3½	9.621	42000	52500	7	38.48	84000	10500
3⅝	10.32	43500	54400	7½	44.18	90000	11250
3¾	11.05	45000	56300	8	50.27	96000	12000
3⅞	11.79	46500	58100	8½	56.75	102000	12750
4	12.57	48000	60000	9	63.62	108000	13500
4⅛	13.36	49500	61900	10	78.54	120000	15000
4¼	14.19	51000	63800	11	95.03	132000	16500
4⅜	15.03	52500	65600	12	113.10	144000	18000

STANDARD PIN-NUTS

Pins	Pin-Nuts					Pins		Pin-Nuts				
Diameter of Screw	Threads per Inch	Short Diameter	Long Diameter	Thickness	Weight	Diameter of Pin	Diameter of Screw	Threads per Inch	Short Diameter	Long Diameter	Thickness	Weight
1¼	8	2¼	2⅝	⅞	0.85	3⅞	3¼	6	5	5¾	1¼	4.74
1½	8	2½	2⅞	31/32	1.03	4⅛	3½	6	5½	6⅜	1¼	6.19
1⅝	8	2½	2⅞	1	0.97	4⅜	3½	6	5½	6⅜	1¼	6.19
1¾	8	3	3½	1	1.50	4⅝	3¾	6	5½	6⅜	1¼	5.37
1⅞	8	3	3½	1	1.37	4⅞	4	6	6	6 15/16	1¼	6.63
2	8	3½	4	1	2.06	5⅛	4	6	6	6 15/16	1¼	6.63
2⅛	8	3½	4	1	1.96	5⅜	4¼	6	6	6 15/16	1¼	5.82
2¼	8	4	4⅝	1¼	3.38	5⅝	4½	6	6¾	7 13/16	1¼	8.58
2⅜	8	4	4⅝	1¼	3.22	5⅞	4¾	6	6¾	7 13/16	1¼	7.59
2½	8	4¼	4⅞	1¼	3.63	6⅛	4¾	6	6¾	7 13/16	1¼	7.59
2⅝	8	4¼	4⅞	1¼	3.41	6⅜	5	6	8	9¼	1¼	13.06
2¾	6	4½	5 3/16	1¼	4.09	6⅝	5¼	6	8	9¼	1½	14.86
2⅞	6	4¾	5½	1¼	4.63	6⅞	5½	6	8	9¼	1½	14.00
3	6	5	5¾	1¼	5.25	7⅛	5¾	6	8	9¼	1½	13.10

All dimensions given above are in inches.
Weights refer to untapped nuts.

WOOD SCREWS

(Not Manufactured by Carnegie Steel Co.)

Diameter = Number × 0.01325 + 0.056

Diam.	No.	Diam.	No.	Diam.	No.	Diam.	No.	Diam.
.056	6	.135	12	.215	18	.293	24	.374
.069	7	.149	13	.228	19	.308	25	.387
.082	8	.162	14	.241	20	.321	26	.401
.096	9	.175	15	.255	21	.334	27	.414
.109	10	.188	16	.268	22	.347	28	.427
.122	11	.201	17	.281	23	.361	29	.440
							30	.453

WEIGHT OF RIVETS AND ROUND-HEA
BOLTS WITHOUT NUTS PER 100
STEEL

Length Inches	⅜ In. Diam.	½ In. Diam.	⅝ In. Diam.	¾ In. Diam.	⅞ In. Diam.	1 In. Diam.	1⅛ Dia
1¼	5.5	12.8	22.0	29.3	43.9	66.6	93
1½	6.3	14.2	24.1	32.4	48.2	72.1	100
1¾	7.0	15.5	26.3	35.5	52.5	77.7	107
2	7.9	16.9	28.5	38.7	56.7	83.3	114
2¼	8.7	18.3	30.7	41.8	61.0	88.8	121
2½	9.4	19.7	32.8	44.9	65.2	94.4	128
2¾	10.2	21.1	35.0	48.0	69.5	100.	136
3	11.0	22.5	37.2	51.1	73.7	105.	143
3¼	11.7	23.9	39.3	54.3	78.0	111.	150
3½	12.6	25.3	41.5	57.4	82.3	116.	157
3¾	13.4	26.7	43.7	60.5	86.5	122.	164
4	14.1	28.1	45.9	63.6	90.8	128.	170
4¼	14.9	29.4	48.0	66.7	95.0	134.	177
4½	15.7	30.8	50.2	69.9	99.3	139.	185
4¾	16.5	32.2	52.4	73.0	104.	145.	192
5	17.2	33.6	54.5	76.1	108.	150.	199
5¼	18.1	35.0	56.7	79.2	112.	156.	206
5½	18.8	36.4	58.9	82.3	116.	161.	213
5¾	19.6	37.8	61.1	85.5	120.	166.	220
6	20.4	39.2	63.2	88.6	124.	172.	227
6½	21.9	42.0	67.6	95.1	133.	184.	241
7	23.5	44.7	71.9	101.	142.	195.	255
7½	25.1	47.5	76.1	108.	150.	206.	269
8	26.6	50.3	80.6	114.	159.	217.	284
8½	28.2	53.1	85.0	120.	167.	227.	298
9	29.8	55.9	89.3	126.	176.	239.	312
9½	31.3	58.7	93.7	133.	185.	250.	325
10	32.8	61.4	98.0	139.	193.	261.	340
10½	34.5	64.2	103.	145.	202.	272.	354
11	36.0	67.0	107.	151.	210.	284.	368
11½	37.6	69.8	111.	158.	218.	295.	382
12	39.2	72.5	115.	164.	227.	306.	396
Heads	1.8	5.8	11.1	13.6	22.6	39.0	58

WEIGHT IN POUNDS OF 100 BOLTS WITH SQUARE HEADS AND NUTS

Length Under Head to Point	Diameter of Bolts								
	1/4 In.	5/16 In.	3/8 In.	7/16 In.	1/2 In.	5/8 In.	3/4 In.	7/8 In.	1 In.
1 1/2	4.0	7.0	10.5	15.2	22.5	39.5	63.0	....	....
1 3/4	4.4	7.5	11.3	16.3	23.8	41.6	66.0	....	....
2	4.8	8.0	12.0	17.4	25.2	43.8	69.0	109.0	163
2 1/4	5.2	8.5	12.8	18.5	26.5	45.8	72.0	113.3	169
2 1/2	5.5	9.0	13.5	19.6	27.8	48.0	75.0	117.5	174
2 3/4	5.8	9.5	14.3	20.7	29.1	50.1	78.0	121.8	180
3	6.3	10.0	15.0	21.8	30.5	52.3	81.0	126.0	185
3 1/2	7.0	11.0	16.5	24.0	33.1	56.5	87.0	134.3	196
4	7.8	12.0	18.0	26.2	35.8	60.8	93.1	142.5	207
4 1/2	8.5	13.0	19.5	28.4	38.4	65.0	99.1	151.0	218
5	9.3	14.0	21.0	30.6	41.1	69.3	105.2	159.6	229
5 1/2	10.0	15.0	22.5	32.8	43.7	73.5	111.3	168.0	240
6	10.8	16.0	24.0	35.0	46.4	77.8	117.3	176.6	251
6 1/2	....	....	25.5	37.2	49.0	82.0	123.4	185.0	262
7	....	....	27.0	39.4	51.7	86.3	129.4	193.7	273
7 1/2	....	....	28.5	41.6	54.3	90.5	135.0	202.0	284
8	....	....	30.0	43.8	59.6	94.8	141.5	210.7	295
9	....	....	....	46.0	64.9	103.3	153.6	227.8	317
10	....	....	....	48.2	70.2	111.8	165.7	244.8	339
11	....	....	....	50.4	75.5	120.3	177.8	261.9	360
12	....	....	....	52.6	80.8	128.8	189.9	278.9	382
13	....	....	....	....	86.1	137.3	202.0	296.0	404
14	....	....	....	....	91.4	145.8	214.1	313.0	426
15	....	....	....	....	96.7	154.3	226.2	330.1	448
16	....	....	....	....	102.0	162.8	238.3	347.1	470
17	....	....	....	....	107.3	171.0	250.4	364.2	492
18	....	....	....	....	112.6	179.5	262.6	381.2	514
19	....	....	....	....	117.9	188.0	274.7	398.3	536
20	....	....	...	....	123.2	206.5	286.8	415.3	558
Per Inch Additional	1.4	2.1	3.1	4.2	5.5	8.5	12.3	16.7	21.8

WEIGHTS OF NUTS AND BOLT-HEADS IN POUNDS

FOR CALCULATING THE WEIGHT OF LONGER BOLTS

Diameter of Bolt in Inches		1/4	3/8	1/2	5/8	3/4	7/8
Weight of Hexagon Nut and Head.....	....	.017	.057	.128	.267	.43	.73
Weight of Square Nut and Head.....	....	.021	.069	.164	.320	.55	.88
Diameter of Bolt in Inches	**1**	**1 1/4**	**1 1/2**	**1 3/4**	**2**	**2 1/2**	**3**
Weight of Hexagon Nut and Head.....	1.10	2.14	3.78	5.6	8.75	17.0	28.8
Weight of Square Nut and Head.....	1.31	2.56	4.42	7.0	10.5	21.0	36.4

DIMENSIONS AND WEIGHTS OF HOT PRESSE SQUARE NUTS

The sizes are the usual manufacturers', not the Franklin Institu Standard. Both weights and sizes are for the unfinished nut

Size of Bolt	Weight of 100 Nuts	Rough Hole	Thickness of Nut	Side of Square	Diagonal	No. of Nuts i 100 lbs.
1/4	1.5	7/32	1/4	1/2	.71	6800
5/16	2.9	9/32	5/16	5/8	.88	3480
3/8	4.9	11/32	3/8	3/4	1.06	2050
7/16	7.7	13/32	7/16	7/8	1.24	1290
1/2	8.6	7/16	1/2	7/8	1.24	1170
1/2	11.8	7/16	1/2	1	1.41	850
9/16	16.7	1/2	9/16	1 1/8	1.59	600
5/8	17.7	9/16	5/8	1 1/8	1.59	570
	22.8	9/16	5/8	1 1/4	1.77	440
3/4	32.3	21/32	3/4	1 3/8	1.94	310
3/4	39.8	21/32	3/4	1 1/2	2.12	251
7/8	53.	25/32	7/8	1 5/8	2.30	190
7/8	63.	25/32	7/8	1 3/4	2.47	159
1	68.	7/8	1	1 3/4	2.47	146
1	94.	7/8	1	2	2.83	106
1 1/8	103.	15/16	1 1/8	2	2.83	97
1 1/8	137.	15/16	1 1/8	2 1/4	3.18	73
1 1/4	145.	1 1/16	1 1/4	2 1/4	3.18	69
1 1/4	186.	1 1/16	1 1/4	2 1/2	3.54	54
1 3/8	247.	1 3/16	1 3/8	2 3/4	3.89	41
1 1/2	319.	1 5/16	1 1/2	3	4.24	31.3
1 5/8	400.	1 7/16	1 5/8	3 1/4	4.60	24.8
1 3/4	500.	1 9/16	1 3/4	3 1/2	4.95	19.9
1 7/8	620.	1 11/16	1 7/8	3 3/4	5.30	16.2
2	750.	1 13/16	2	4	5.66	13.[illegible]
2 1/8	780.	1 7/8	2 1/8	4	5.66	12.8
2 1/4	930.	2	2 1/4	4 1/4	6.01	10.[illegible]
2 3/8	960.	2 1/8	2 3/8	4 1/4	6.01	10.[illegible]
2 1/2	1130.	2 1/4	2 1/2	4 1/2	6.36	8.[illegible]
2 3/4	1370.	2 7/16	2 3/4	4 3/4	6.72	7.[illegible]
3	1610.	2 11/16	3	5	7.07	6.[illegible]
3 1/4	2110.	2 15/16	3 1/4	5 1/2	7.78	4.[illegible]
3 1/2	2750.	3 1/8	3 1/2	6	8.49	3.[illegible]

DIMENSIONS AND WEIGHTS OF HOT PRESSED HEXAGON NUTS

sizes are the usual manufacturers', not the Franklin Institute Standard. Both weights and sizes are for the unfinished nut

…e of Bolt	Weight of 100 Nuts	Rough Hole	Thickness of Nut	Short Diameter	Long Diameter	No. of Nuts in 100 lbs.
¼	1.3	$\frac{7}{32}$	¼	½	.58	8000
$\frac{5}{16}$	2.4	$\frac{9}{32}$	$\frac{5}{16}$	⅝	.72	4170
⅜	4.1	$\frac{11}{32}$	⅜	¾	.87	2410
$\frac{7}{16}$	6.8	$\frac{13}{32}$	$\frac{7}{16}$	⅞	1.01	1460
½	7.1	$\frac{7}{16}$	½	⅞	1.01	1410
½	9.8	$\frac{7}{16}$	½	1	1.15	1020
$\frac{9}{16}$	14.0	½	$\frac{9}{16}$	1⅛	1.30	710
⅝	14.7	$\frac{9}{16}$	⅝	1⅛	1.30	680
⅝	19.1	$\frac{9}{16}$	⅝	1¼	1.44	520
⅝	22.9	$\frac{9}{16}$	¾	1¼	1.44	440
¾	27.2	$\frac{21}{32}$	¾	1⅜	1.59	370
¾	39.	$\frac{21}{32}$	⅞	1½	1.73	256
⅞	44.	$\frac{25}{32}$	⅞	1⅝	1.88	226
⅞	50.	$\frac{25}{32}$	1	1⅝	1.88	198
1	57.	⅞	1	1¾	2.02	176
1	64.	⅞	1⅛	1¾	2.02	156
1⅛	96.	$\frac{15}{16}$	1¼	2	2.31	104
1¼	134.	$1\frac{1}{16}$	1⅜	2¼	2.60	75
1⅜	180.	$1\frac{3}{16}$	1½	2½	2.89	56
1½	235.	$1\frac{5}{16}$	1⅝	2¾	3.18	42
1⅝	300.	$1\frac{7}{16}$	1¾	3	3.46	33.4
1¾	370.	$1\frac{9}{16}$	1⅞	3¼	3.75	26.7
1⅞	460.	$1\frac{11}{16}$	2	3½	4.04	21.5
[illegible]	450.	$1\frac{13}{16}$	2	3½	4.04	22.4
…⅛	560.	1⅞	2⅛	3¾	4.33	18.0
…¼	560.	2	2¼	3¾	4.33	17.7
…⅜	680.	2⅛	2⅜	4	4.62	14.7
…½	810.	2¼	2½	4¼	4.91	12.3
…¾	980.	$2\frac{7}{16}$	2¾	4½	5.20	10.2
[illegible]	1150.	$2\frac{11}{16}$	3	4¾	5.48	8.7
…¼	1340.	$2\frac{15}{16}$	3¼	5	5.77	7.5
…½	1580.	3⅛	3½	5¼	6.06	6.3

UPSET SCREW ENDS FOR ROUND AN SQUARE BARS

Diameter of Round or Side of Square Bar Inches	Round Bars				Square Bars		
	Diameter of Upset Screw End Inches	Diameter of Screw at Root of Thread Inches	Threads per Inch No.	Excess of Effective Area of Screw End Over Bar Per Cent	Diameter of Upset Screw End Inches	Diameter of Screw at Root of Thread Inches	Threads per Inch No.
1/2	3/4	.620	10	54	3/4	.620	10
9/16	3/4	.620	10	21	7/8	.731	9
5/8	7/8	.731	9	37	1	.837	8
11/16	1	.837	8	48	1	.837	8
3/4	1	.837	8	25	1 1/8	.940	7
13/16	1 1/8	.940	7	34	1 1/4	1.065	7
7/8	1 1/4	1.065	7	48	1 3/8	1.160	6
15/16	1 1/4	1.065	7	29	1 3/8	1.160	6
1	1 3/8	1.160	6	35	1 1/2	1.284	6
1 1/16	1 3/8	1.160	6	19	1 5/8	1.389	5 1/2
1 1/8	1 1/2	1.284	6	30	1 5/8	1.389	5 1/2
1 3/16	1 1/2	1.284	6	17	1 3/4	1.490	5
1 1/4	1 5/8	1.389	5 1/2	23	1 7/8	1.615	5
1 5/16	1 3/4	1.490	5	29	1 7/8	1.615	5
1 3/8	1 3/4	1.490	5	18	2	1.712	4 1/2
1 7/16	1 7/8	1.615	5	26	2 1/8	1.837	4 1/2
1 1/2	2	1.712	4 1/2	30	2 1/8	1.837	4 1/2
1 9/16	2	1.712	4 1/2	20	2 1/4	1.962	4 1/2
1 5/8	2 1/8	1.837	4 1/2	28	2 3/8	2.087	4 1/2
1 11/16	2 1/8	1.837	4 1/2	18	2 3/8	2.087	4 1/2
1 3/4	2 1/4	1.962	4 1/2	26	2 1/2	2.175	4
1 13/16	2 1/4	1.962	4 1/2	17	2 5/8	2.300	4
1 7/8	2 3/8	2.087	4 1/2	24	2 5/8	2.300	4
1 15/16	2 1/2	2.175	4	26	2 3/4	2.425	4
2	2 1/2	2.175	4	18	2 7/8	2.550	4
2 1/16	2 5/8	2.300	4	24	2 7/8	2.550	4
2 1/8	2 5/8	2.300	4	17	3	2.629	3 1/2
2 3/16	2 3/4	2.425	4	23	3 1/8	2.754	3 1/2

UPSET SCREW ENDS
(Continued)

Round Bars				Square Bars			
Diameter of Upset Screw End Inches	Diameter of Screw at Root of Thread Inches	Threads per Inch No.	Excess of Effective Area of Screw End Over Bar Per Cent.	Diameter of Upset Screw End Inches	Diameter of Screw at Root of Thread Inches	Threads per Inch No.	Excess of Effective Area of Screw End Over Bar Per Cent.
2⅞	2.550	4	28	3⅛	2.754	3½	18
2⅞	2.550	4	22	3¼	2.879	3½	22
3	2.629	3½	23	3⅜	3.004	3½	26
3⅛	2.754	3½	28	3⅜	3.004	3½	19
3⅛	2.754	3½	21	3½	3.100	3¼	21
3¼	2.879	3½	26	3⅝	3.225	3¼	24
3¼	2.879	3½	20	3⅝	3.225	3¼	19
3⅜	3.004	3½	25	3¾	3.317	3	20
3⅜	3.004	3½	19	3⅞	3.442	3	23
3½	3.100	3¼	22	3⅞	3.442	3	18
3⅝	3.225	3¼	26	4	3.567	3	21
3⅝	3.225	3¼	21	4⅛	3.692	3	24
3¾	3.317	3	22	4⅛	3.692	3	19
3⅞	3.442	3	21	4⅜	3.923	2⅞	24
4	3.567	3	20	4½	4.028	2¾	21
4⅛	3.692	3	20	4⅝	4.153	2¾	19
4¼	3.798	2⅞	18	...	.....	...	..
4½	4.028	2¾	23	...	.....	...	..
4⅝	4.153	2¾	23	...	.....	...	..
4¾	4.255	2⅝	21	...	.....	...	..

MARKS—As upsetting reduces the strength, bars having the same ter at root of thread as that of the bar invariably break in the end when tested to destruction, without developing the full th of the bar. It is therefore necessary to make up for this loss ngth by an excess of metal in the upset screw ends over that in r.

e above table is the result of numerous tests on finished bars by Carnegie Steel Company, and gives proportions that will cause r to break in the body in preference to the upset end.

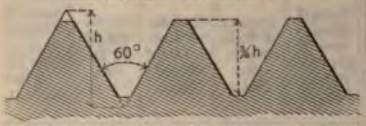
e screw threads in above table are the Franklin Institute rd.

make *one upset end* for 5 in. length of thread, allow 6 in. length *additional*.

STANDARD SCREW THREADS, NUTS AND BOLT HEA

Recommended by the Franklin Institute

SCREW THREADS



Angle of Thread 60°. Flat at Top and Bottom = ⅛ of Pitch

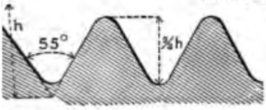
Diameter of Screw, Inches	Diameter at Root of Thread, Inches	Threads per Inch No.
¼	.185	20
5/16	.240	18
⅜	.294	16
7/16	.344	14
½	.400	13
9/16	.454	12
⅝	.507	11
¾	.620	10
⅞	.731	9
1	.837	8
1⅛	.940	7
1¼	1.065	7
1⅜	1.160	6
1½	1.284	6
1⅝	1.389	5½
1¾	1.490	5
1⅞	1.615	5
2	1.712	4½
2¼	1.962	4½
2½	2.175	4
2¾	2.425	4
3	2.629	3½
3¼	2.879	3½
3½	3.100	3¼
3¾	3.317	3
4	3.567	3
4¼	3.798	2⅞
4½	4.028	2¾
4¾	4.255	2⅝
5	4.480	2½
5¼	4.730	2½
5½	4.953	2⅜
5¾	5.203	2⅜
6	5.423	2¼

Nuts and bolt hea
determined by the foll
rules, which apply to
square and hexagon
Short dia. of rough nu
= 1½ × dia. of bolt +
Short dia. of finished n
= 1½ × dia. of bolt +
Thickness of rough nu
= dia. of bolt.
Thickness of finished
= dia. of bolt − $\frac{1}{16}$ in.
Short dia. of rough hea
= 1½ × dia. of bolt +
Short dia. of finished h
= 1½ × dia. of bolt +
Thickness of rough hea
= ½ short dia. of hea
Thickness of finished h
= dia. of bolt − $\frac{1}{16}$ in.

The long diameter
hexagon nut may be
tained by multiplyin
short diameter by 1.1
the long diameter of a s
nut by multiplying the
diameter by 1.414.

The above standar
screw threads, nuts an
heads were recomm
by the Franklin Instit
December, 1864. The
ard for screw thread
been very generally ad
in the United States, b
proportions recomm
for nuts and bolt head
not found general a
ance because of the
sizes of bar—not u
rolled by the mills—rec
to make the nut.

'WORTH'S STANDARD ANGULAR SCREW THREADS



Angle of thread 55°.

Depth of thread = pitch of screw.

⅙ of depth is rounded off at top and bottom.

ıber of threads to the inch in square threads = ½ the number lar threads.

Threads to the inch No.	Diam. of Screw Inches	Threads to the Inch No.	Diam. of Screw Inches	Threads to the inch No.	Diam. of Screw Inches	Threads to the Inch No.
20	1	8	2	4½	4	3
18	1⅛	7	2¼	4	4¼	2⅞
16	1¼	7	2½	4	4½	2⅞
14	1⅜	6	2¾	3½	4¾	2¾
12	1½	6	3	3½	5	2¾
11	1⅝	5	3¼	3¼	5¼	2⅝
10	1¾	5	3½	3¼	5½	2⅝
9	1⅞	4½	3¾	3	5¾	2½
					6	2½

ANDARD STEAM, GAS AND WATER PIPE

As manufactured by the National Tube Works Co.

Diameter in Inches		Thickness Inches	Length of Pipe Containing One Cubic Foot	Nominal Weight per Foot Pounds	Number of Threads per Inch of Screw
Actual External	Actual Internal				
.405	.27	.068	2513.	0.24	27
.54	.364	.088	1383.3	0.42	18
.675	.494	.091	751.2	0.56	18
.84	.623	.109	472.4	0.84	14
1.05	.824	.113	270.	1.12	14
1.315	1.048	.134	166.9	1.67	11½
1.66	1.38	.140	96.25	2.24	11½
1.9	1.611	.145	70.66	2.68	11½
2.375	2.067	.154	42.91	3.61	11½
2.875	2.468	.204	30.1	5.74	8
3.5	3.067	.217	19.5	7.54	8
4.	3.548	.226	14.57	9.00	8
4.5	4.026	.237	11.31	10.66	8
5.	4.508	.246	9.02	12.49	8
5.563	5.045	.259	7.2	14.50	8
6.625	6.065	.280	4.98	18.76	8
7.625	7.023	.301	3.72	23.27	8
8.625	7.982	.322	2.88	28.18	8
9.625	8.937	.344	2.29	33.70	8
10.75	*10.019*	.366	1.82	40.00	8

SPIKES, NAILS AND TACKS

Standard Steel Wire Nails						Steel Wire Spikes			Common Iron Nails		
Sizes	Length Inches	Common		Finishing		Length Inches	Diam. Inches	No. per Pound	Sizes	Length Inches	No. per Pound
		Diam. Inches	No. per pound	Diam. Inches	No. per Pound						
2d	1	.0524	1060	.0453	1558	3	.1620	41	2d	1	800
3d	1¼	.0588	640	.0508	913	3½	.1819	30	3d	1¼	400
4d	1½	.0720	380	.0508	761	4	.2043	23	4d	1½	300
5d	1¾	.0764	275	.0571	500	4½	.2294	17	5d	1¾	200
6d	2	.0808	210	.0641	350	5	.2576	13	6d	2	150
7d	2¼	.0858	160	.0641	315	5½	.2893	11	7d	2¼	120
8d	2½	.0935	115	.0720	214	6	.2893	10	8d	2½	85
9d	2¾	.0963	93	.0720	195	6½	.2249	7½	9d	2¾	75
10d	3	.1082	77	.0808	137	7	.2249	7	10d	3	60
12d	3¼	.1144	60	.0808	127	8	.3648	5	12d	3¼	50
16d	3½	.1285	48	.0907	90	9	.3648	4½	16d	3½	40
20d	4	.1620	31	.1019	62	....	....	....	20d	4	20
30d	4½	.1819	22	....	....	....	....	....	30d	4½	16
40d	5	.2043	17	....	....	....	....	....	40d	5	14
50d	5½	.2294	13	....	....	....	....	....	50d	5½	11
60d	6	.2576	11	....	....	....	....	....	60d	6	8

TACKS

Title Ounce	Length Inches	Number per Pound	Title Ounce	Length Inches	Number per Pound	Title Ounce	Length Inches	Number per Pound
1	1/8	16000	4	7/16	4000	14	13/16	1143
1½	3/16	10666	6	9/16	2666	16	7/8	1000
2	1/4	8000	8	5/8	2000	18	15/16	888
2½	5/16	6400	10	11/16	1600	20	1	800
3	3/8	5333	12	3/4	1333	22	1 1/16	727
						24	1 1/8	666

WROUGHT SPIKES

Number to a Keg of 150 lbs.

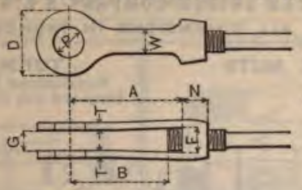
Length Inches	¼ in. No.	5/16 in. No.	3/8 in. No.	Length Inches	¼ in. No.	5/16 in. No.	3/8 in. No.	7/16 in. No.	½ in. No.
3	2250	....	....	7	1161	662	482	445	306
3½	1890	1208	....	8	....	635	455	384	256
4	1650	1135	....	9	....	578	424	300	240
4½	1464	1064	....	10	....	....	391	270	222
5	1380	930	742	11	....	....	....	249	203
6	1292	868	570	12	....	....	....	236	180

(Not manufactured by Carnegie Steel Company)

CLEVISES

AMERICAN BRIDGE COMPANY'S STANDARDS

All dimensions in
hes



Grip G can be made to suit connections

m. of ris D.	Max. Pin P	Clevis						Diam. of Clevis D
		Fork F	Nut N	Width W	Thickness T	A	B	
[illegible]	1½	1½	1½	1½	⅜	6	5	3
[illegible]	2¼	1¾	1¾	1¾	½	9	8	4
[illegible]	3	2¼	2¼	2¼	⅝	9	8	5
[illegible]	3½	2¾	2¾	2¾	¾	9	8	6
[illegible]	4	3¼	3¼	3¼	⅞	9	8	7

TABLE GIVING DIAMETER OF CLEVIS FOR GIVEN ROD AND PIN

Rod Square	Rod Upset	Pins 1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	3¾	4	Rod Upset	Rod Square	Rod Round
⅝	1	3	3	3											1	⅝	¾
¾	1⅛	3	3	3	4	4	4								1⅛	¾	
⅞	1¼		4	4	4	4	4								1¼	⅞	⅞
	1⅜		4	4	4	4	4								1⅜		1
1	1½		4	4	4	4	4	5	5	5					1½	1	1⅛
1⅛	1⅝			4	4	5	5	5	5	5					1⅝	1⅛	1¼
	1¾			5	5	5	5	5	5	5					1¾		1⅜
1¼	1⅞			5	5	5	5	5	5	5					1⅞	1¼	
1⅜	2				5	5	5	5	5	6	6	6			2	1⅜	1½
	2⅛				5	5	5	5	6	6	6	6			2⅛		1⅝
1½	2¼					6	6	6	6	6	6	7	7	7	2¼	1½	1¾
1⅝	2⅜					6	6	6	6	7	7	7	7	7	2⅜	1⅝	1⅞
1¾	2½						6	6	7	7	7	7	7	7	2½	1¾	2
	2⅝							7	7	7	7	7			2⅝		2⅛
1⅞	2¾							7	7	7	7	7			2¾	1⅞	
2	2⅞								7	7					2⅞	2	2¼
Square	Upset	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	3¾	4	Upset	Square	Round
Rod		Pins													Rod		

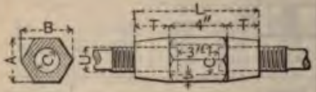
Clevises above and to right of heavy zigzag line may be used with forks straight. Clevises below and to left of same line should have forks closed in until pin is not trained. (Not manufactured by Carnegie Steel Company.)

SLEEVE NUTS AND TURNBUCKLES

AMERICAN BRIDGE COMPANY'S STANDARDS

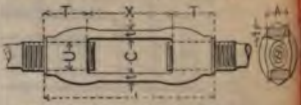
ALL DIMENSIONS IN INCHES

SLEEVE NUTS



TURNBUCKLES

Manufactured by the Cleveland City Forge and Iron Co., Cleveland, O.

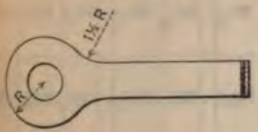
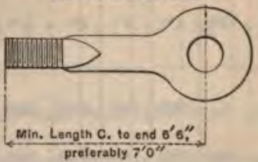


Standard Length, X = 6 in.
Extra Lengths, 9, 12, 18, 24, 36, 48 and 72 in. (Special Prices)

Sleeve Nuts: Diameter of Screw U	Length of Thread T	Length of Nut L	Short Diam. A	Long Diam. B	Inside Diam. C	Thickness t	Weight in Pounds	Turnbuckles: Weight in Pounds	Standard Dimensions: t	A	B	C	L	T	Diameter of Screw U
7/8	1 1/2	7	1 5/8	1 7/8	1 1/8	1/4	2 1/4	2 1/2	3/8	1 1/4	2 1/4	1 1/4	8 5/8	1 5/16	7/8
1	1 1/2	7	1 5/8	1 7/8	1 1/8	1/4	3	3 1/2	7/16	1 1/4	2 7/16	1 5/16	9	1 1/2	1
1 1/8	1 3/4	7 1/2	2	2 5/16	1 3/8	5/16	3 1/2	4	1/2	1 1/4	2 9/16	1 7/16	9 3/8	1 11/16	1 1/8
1 1/4	1 3/4	7 1/2	2	2 5/16	1 3/8	5/16	4	5 1/4	1/2	1 1/2	2 3/4	1 9/16	9 3/4	1 7/8	1 1/4
1 3/8	2	8	2 3/8	2 3/4	1 5/8	3/8	4 1/2	6	1/2	1 5/8	3 1/16	1 11/16	10 1/8	2 1/16	1 3/8
1 1/2	2	8	2 3/8	2 3/4	1 5/8	3/8	6 1/2	7	5/8	1 5/8	3 3/16	1 3/4	10 1/2	2 1/4	1 1/2
1 5/8	2 1/4	8 1/2	2 3/4	3 3/16	1 7/8	7/16	8	8 1/2	5/8	1 3/4	3 1/2	2	10 7/8	2 7/16	1 5/8
1 3/4	2 1/4	8 1/2	2 3/4	3 3/16	1 7/8	7/16	8 1/2	10	5/8	2	3 3/4	2 1/8	11 1/4	2 5/8	1 3/4
1 7/8	2 1/2	9	3 1/8	3 5/8	2 1/8	1/2	10	11 1/2	11/16	2	3 7/8	2 3/16	11 5/8	2 11/16	1 7/8
2	2 1/2	9	3 1/8	3 5/8	2 1/8	1/2	11	13	11/16	2 1/4	4 1/4	2 3/8	12	3	2
2 1/8	2 3/4	9 1/2	3 1/2	4 1/16	2 3/8	9/16	14	15	23/32	2 1/2	4 1/2	2 1/2	12 3/8	3 3/16	2 1/8
2 1/4	2 3/4	9 1/2	3 1/2	4 1/16	2 3/8	9/16	15	18	13/16	2 1/2	4 3/4	2 11/16	12 3/4	3 3/8	2 1/4
2 3/8	3	10	3 7/8	4 1/2	2 5/8	5/8	18	20	13/16	2 3/4	4 7/8	2 3/4	13 1/8	3 9/16	2 3/8
2 1/2	3	10	3 7/8	4 1/2	2 5/8	5/8	19	24	27/32	3	5 3/8	3 1/16	13 1/2	3 3/4	2 1/2
2 5/8	3 1/4	10 1/2	4 1/4	4 13/16	2 7/8	11/16	22	28	15/16	3	5 9/16	3 1/8	13 7/8	3 15/16	2 5/8
2 3/4	3 1/4	10 1/2	4 1/4	4 15/16	2 7/8	11/16	23	30	15/16	3 1/4	5 3/4	3 1/4	14 1/4	4 1/8	2 3/4
2 7/8	3 1/2	11	4 5/8	5 3/8	3 1/8	3/4	27	34	1 1/32	3 1/4	6 1/16	3 7/16	14 5/8	4 3/16	2 7/8
3	3 1/2	11	4 5/8	5 3/8	3 1/8	3/4	28	38	1 1/32	3 1/2	6 3/8	3 5/8	15	4 1/2	3
3 1/8	3 3/4	11 1/2	5	5 13/16	3 3/8	13/16	34	....	...	...	...	...	....	...	3 1/8
3 1/4	3 3/4	11 1/2	5	5 13/16	3 3/8	13/16	35	50	1 1/16	4	6 3/4	3 7/8	15 1/4	4 7/8	3 1/4
3 3/8	4	12	5 3/8	6 1/8	3 5/8	7/8	39	....	...	...	...	...	....	...	3 3/8
3 1/2	4	12	5 3/8	6 1/8	3 5/8	7/8	40	65	1 7/32	4	7 1/4	4 1/4	16 1/2	5 1/4	3 1/2
3 5/8	4 1/4	12 1/2	5 3/4	6 11/16	3 7/8	15/16	45	....	...	...	...	...	....	...	3 5/8
3 3/4	4 1/4	12 1/2	5 3/4	6 11/16	3 7/8	15/16	47	....	1 5/16	5	8 1/4	4 7/16	18	6	3 3/4
3 7/8	4 1/2	13	6 1/8	7 1/8	4 1/8	1	52	....	...	...	...	...	....	...	3 7/8
4	4 1/2	13	6 1/8	7 1/8	4 1/8	1	55	....	1 7/16	5	8 3/4	4 1/2	18	6	4
4 1/4	4 3/4	13 1/2	6 1/2	7 9/16	4 3/8	1 1/16	65	....	...	...	...	...	....	...	4 1/4
4 1/2	5	14	6 7/8	8	4 3/4	1 1/16	75	....	...	...	...	...	....	...	4 1/2

(Not manufactured by Carnegie Steel Co.)

EYE BARS
AMERICAN BRIDGE COMPANY'S STANDARDS

ORDINARY	ADJUSTABLE
	

Width of Bar Inches	Min. Thickness of Bar Inches	Head			Screw End			Thickness of Bar Inches	Width of Bar Inches
		Diam. Inches	Max. Pin Inches	Additional Material for 1 Head Ft. and Ins.	Additional Material for Upset Ft. and Ins.	Diam. Inches	Length Inches		
2	5/8	4 1/2	1 3/4	0—10	0—7	3	5	15/16	2
	5/8	5 1/2	2 3/4	1—2					
2½	3/4	5 1/2	2 1/4	0—11	1—1	2 1/4	5	13/16 to 1 1/16	2½
	3/4	6 1/2	3 1/4	1—2					
3	3/4	7	3	1—1	1—5	2 1/2	5 1/2	1 to 1 1/16	3
	3/4	8	4	1—5	1—5	2 3/4	6	1 1/8 to 1 1/4	
4	3/4	9 1/2	4 1/4	1—6	1—8	3	6	1 to 1 1/8	4
	7/8	10 1/2	5 1/4	1—9	1—8	3 1/4	6 1/2	1 3/16 to 1 3/8	
	*1	11 1/2	6 1/4	2—3					
5	3/4	11 1/2	5	1—8	1—9	3 1/4	6 1/2	1 to 1 1/16	5
	1	13	6 1/2	2—3	1—9	3 1/2	7	1 1/8 to 1 1/4	
6	3/4	13 1/2	5 1/2	1—10	1—11	3 3/4	8	1 1/8 to 1 3/16	6
	1	14 1/2	6 1/2	2—4	1—11	4	8	1 1/4 to 1 3/8	
7	1	16 1/2	7 1/4	2—4	2—3	4 1/4	9	1 1/4 to 1 5/16	7
	*1 1/8	17 1/2	8 1/4	2—8	2—3	4 1/2	9	1 3/8 to 1 1/2	
8	1	17 1/2	7	2—3	....	....	....	....	8
	1 1/8	18 1/2	8	2—8	....	....	....	....	
	*1 1/4	19 1/2	9	3—0	....	....	....	....	
10	1 1/8	22	9	2—11	....	....	....	....	10
	1 1/4	23 1/2	10 1/2	3—4	....	....	....	....	
	*1 3/8	24 1/2	11 1/2	3—8	....	....	....	....	
12	1 1/4	26	10	3—3	....	....	....	....	12
	1 3/8	27 1/2	11 1/2	3—9	....	....	....	....	
	*1 1/2	29	13	4—2	....	....	....	....	
14	1 3/8	30 1/2	12	3—10	....	....	....	....	14
	1 1/2	32 1/2	14	4—5	....	....	....	....	
	*1 5/8	33 1/2	15	4—8	....	....	....	....	

*Bars marked * should only be used when absolutely unavoidable.*

Note: Eye bars are hydraulic forged and are guaranteed to develo[p] the full strength of the bar, under conditions given in the above tab[le] when tested to destruction.

(Not manufactured by Carnegie Steel Company)

DECIMALS OF A FOOT FOR EACH $\frac{1}{64}$th OF AN INCH

Inch	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″
0	0	.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	[illegible]
$\frac{1}{64}$	.0013	.0846	.1680	.2513	.3346	.4180	.5013	.5846	.6680	.7513	.8346	[illegible]
$\frac{1}{32}$	.0026	.0859	.1693	.2526	.3359	.4193	.5026	.5859	.6693	.7526	.8359	[illegible]
$\frac{3}{64}$	.0039	.0872	.1706	.2539	.3372	.4206	.5039	.5872	.6706	.7539	.8372	[illegible]
$\frac{1}{16}$	.0052	.0885	.1719	.2552	.3385	.4219	.5052	.5885	.6719	.7552	.8385	[illegible]
$\frac{5}{64}$	.0065	.0898	.1732	.2565	.3398	.4232	.5065	.5898	.6732	.7565	.8398	[illegible]
$\frac{3}{32}$	.0078	.0911	.1745	.2578	.3411	.4245	.5078	.5911	.6745	.7578	.8411	[illegible]
$\frac{7}{64}$	.0091	.0924	.1758	.2591	.3424	.4258	.5091	.5924	.6758	.7591	.8424	[illegible]
$\frac{1}{8}$	.0104	.0937	.1771	.2604	.3437	.4271	.5104	.5937	.6771	.7604	.8437	[illegible]
$\frac{9}{64}$	.0117	.0951	.1784	.2617	.3451	.4284	.5117	.5951	.6784	.7617	.8451	[illegible]
$\frac{5}{32}$	.0130	.0964	.1797	.2630	.3464	.4297	.5130	.5964	.6797	.7630	.8464	[illegible]
$\frac{11}{64}$	.0143	.0977	.1810	.2643	.3477	.4310	.5143	.5977	.6810	.7643	.8477	[illegible]
$\frac{3}{16}$	.0156	.0990	.1823	.2656	.3490	.4323	.5156	.5990	.6823	.7656	.8490	[illegible]
$\frac{13}{64}$	.0169	.1003	.1836	.2669	.3503	.4336	.5169	.6003	.6836	.7669	.8503	[illegible]
$\frac{7}{32}$	.0182	.1016	.1849	.2682	.3516	.4349	.5182	.6016	.6849	.7682	.8516	[illegible]
$\frac{15}{64}$	.0195	.1029	.1862	.2695	.3529	.4362	.5195	.6029	.6862	.7695	.8529	[illegible]
$\frac{1}{4}$	.0208	.1042	.1875	.2708	.3542	.4375	.5208	.6042	.6875	.7708	.8542	[illegible]
$\frac{17}{64}$	.0221	.1055	.1888	.2721	.3555	.4388	.5221	.6055	.6888	.7721	.8555	[illegible]
$\frac{9}{32}$	.0234	.1068	.1901	.2734	.3568	.4401	.5234	.6068	.6901	.7734	.8568	[illegible]
$\frac{19}{64}$	.0247	.1081	.1914	.2747	.3581	.4414	.5247	.6081	.6914	.7747	.8581	[illegible]
$\frac{5}{16}$	.0260	.1094	.1927	.2760	.3594	.4427	.5260	.6094	.6927	.7760	.8594	[illegible]
$\frac{21}{64}$	.0273	.1107	.1940	.2773	.3607	.4440	.5273	.6107	.6940	.7773	.8607	[illegible]
$\frac{11}{32}$	.0286	.1120	.1953	.2786	.3620	.4453	.5286	.6120	.6953	.7786	.8620	[illegible]
$\frac{23}{64}$	.0299	.1133	.1966	.2799	.3633	.4466	.5299	.6133	.6966	.7799	.8633	[illegible]
$\frac{3}{8}$	.0312	.1146	.1979	.2812	.3646	.4479	.5312	.6146	.6979	.7812	.8646	[illegible]
$\frac{25}{64}$	.0326	.1159	.1992	.2826	.3659	.4492	.5326	.6159	.6992	.7826	.8659	[illegible]
$\frac{13}{32}$	.0339	.1172	.2005	.2839	.3672	.4505	.5339	.6172	.7005	.7839	.8672	[illegible]
$\frac{27}{64}$	.0352	.1185	.2018	.2852	.3685	.4518	.5352	.6185	.7018	.7852	.8685	[illegible]
$\frac{7}{16}$	.0365	.1198	.2031	.2865	.3698	.4531	.5365	.6198	.7031	.7865	.8698	[illegible]
$\frac{29}{64}$	.0378	.1211	.2044	.2878	.3711	.4544	.5378	.6211	.7044	.7878	.8711	[illegible]
$\frac{15}{32}$	.0391	.1224	.2057	.2891	.3724	.4557	.5391	.6224	.7057	.7891	.8724	[illegible]
$\frac{31}{64}$	.0404	.1237	.2070	.2904	.3737	.4570	.5404	.6237	.7070	.7904	.8737	[illegible]
$\frac{1}{2}$	.0417	.1250	.2083	.2917	.3750	.4583	.5417	.6250	.7083	.7917	.8750	[illegible]

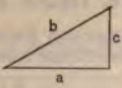
DECIMALS OF A FOOT FOR EACH $\frac{1}{64}$th OF AN INCH

0″	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″
0417	.1250	.2083	.2917	.3750	.4583	.5417	.6250	.7083	.7917	.8750	.9583
0430	.1263	.2096	.2930	.3763	.4596	.5430	.6263	.7096	.7930	.8763	.9596
0443	.1276	.2109	.2943	.3776	.4609	.5443	.6276	.7109	.7943	.8776	.9609
0456	.1289	.2122	.2956	.3789	.4622	.5456	.6289	.7122	.7956	.8789	.9622
0469	.1302	.2135	.2969	.3802	.4635	.5469	.6302	.7135	.7969	.8802	.9635
0482	.1315	.2148	.2982	.3815	.4648	.5482	.6315	.7148	.7982	.8815	.9648
0495	.1328	.2161	.2995	.3828	.4661	.5495	.6328	.7161	.7995	.8828	.9661
0508	.1341	.2174	.3008	.3841	.4674	.5508	.6341	.7174	.8008	.8841	.9674
0521	.1354	.2188	.3021	.3854	.4688	.5521	.6354	.7188	.8021	.8854	.9688
0534	.1367	.2201	.3034	.3867	.4701	.5534	.6367	.7201	.8034	.8867	.9701
0547	.1380	.2214	.3047	.3880	.4714	.5547	.6380	.7214	.8047	.8880	.9714
0560	.1393	.2227	.3060	.3893	.4727	.5560	.6393	.7227	.8060	.8893	.9727
0573	.1406	.2240	.3073	.3906	.4740	.5573	.6406	.7240	.8073	.8906	.9740
0586	.1419	.2253	.3086	.3919	.4753	.5586	.6419	.7253	.8086	.8919	.9753
0599	.1432	.2266	.3099	.3932	.4766	.5599	.6432	.7266	.8099	.8932	.9766
0612	.1445	.2279	.3112	.3945	.4779	.5612	.6445	.7279	.8112	.8945	.9779
0625	.1458	.2292	.3125	.3958	.4792	.5625	.6458	.7292	.8125	.8958	.9792
0638	.1471	.2305	.3138	.3971	.4805	.5638	.6471	.7305	.8138	.8971	.9805
0651	.1484	.2318	.3151	.3984	.4818	.5651	.6484	.7318	.8151	.8984	.9818
0664	.1497	.2331	.3164	.3997	.4831	.5664	.6497	.7331	.8164	.8997	.9831
0677	.1510	.2344	.3177	.4010	.4844	.5677	.6510	.7344	.8177	.9010	.9844
0690	.1523	.2357	.3190	.4023	.4857	.5690	.6523	.7357	.8190	.9023	.9857
0703	.1536	.2370	.3203	.4036	.4870	.5703	.6536	.7370	.8203	.9036	.9870
0716	.1549	.2383	.3216	.4049	.4883	.5716	.6549	.7383	.8216	.9049	.9883
0729	.1562	.2396	.3229	.4062	.4896	.5729	.6562	.7396	.8229	.9062	.9896
0742	.1576	.2409	.3242	.4076	.4909	.5742	.6576	.7409	.8242	.9076	.9909
0755	.1589	.2422	.3255	.4089	.4922	.5755	.6589	.7422	.8255	.9089	.9922
0768	.1602	.2435	.3268	.4102	.4935	.5768	.6602	.7435	.8268	.9102	.9935
0781	.1615	.2448	.3281	.4115	.4948	.5781	.6615	.7448	.8281	.9115	.9948
0794	.1628	.2461	.3294	.4128	.4961	.5794	.6628	.7461	.8294	.9128	.9961
0807	.1641	.2474	.3307	.4141	.4974	.5807	.6641	.7474	.8307	.9141	.9974
0820	.1654	.2487	.3320	.4154	.4987	.5820	.6654	.7487	.8320	.9154	.9987
											1.0000

DECIMALS OF AN INCH FOR EACH $\frac{1}{64}$th

$\frac{1}{32}$	$\frac{1}{64}$	Decimal	Fraction	$\frac{1}{32}$	$\frac{1}{64}$	Decimal	Fract
	1	.015625			33	.515625	
1	2	.03125		17	34	.53125	
	3	.046875			35	.546875	
2	4	.0625	1-16	18	36	.5625	9-
	5	.078125			37	.578125	
3	6	.09375		19	38	.59375	
	7	.109375			39	.609375	
4	8	.125	1-8	20	40	.625	5-
	9	.140625			41	.640625	
5	10	.15625		21	42	.65625	
	11	.171875			43	.671875	
6	12	.1875	3-16	22	44	.6875	11-
	13	.203125			45	.703125	
7	14	.21875		23	46	.71875	
	15	.234375			47	.734375	
8	16	.25	1-4	24	48	.75	3-
	17	.265625			49	.765625	
9	18	.28125		25	50	.78125	
	19	.296875			51	.796875	
10	20	.3125	5-16	26	52	.8125	13
	21	.328125			53	.828125	
11	22	.34375		27	54	.84375	
	23	.359375			55	.859375	
12	24	.375	3-8	28	56	.875	7
	25	.390625			57	.890625	
13	26	.40625		29	58	.90625	
	27	.421875			59	.921875	
14	28	.4375	7-16	30	60	.9375	15
	29	.453125			61	.953125	
15	30	.46875		31	62	.96875	
	31	.484375			63	.984375	
16	*32*	*.5*	1-2	32	64	1.	1

TABLE OF BATTERS



1:2		1:2.5			1:6			1:8		
b	c	a	b	c	a	b	c	a	b	c
9/64"	1/16"	1/8"	9/64"	3/64"	1/8"	1/8"	1/64"	1/8"	1/8"	1/64"
9/32"	1/8"	1/4"	17/64"	7/64"	1/4"	1/4"	3/64"	1/4"	1/4"	1/32"
27/64"	3/16"	3/8"	13/32"	5/32"	3/8"	3/8"	1/16"	3/8"	3/8"	3/64"
9/16"	1/4"	1/2"	35/64"	13/64"	1/2"	1/2"	5/64"	1/2"	1/2"	1/16"
45/64"	5/16"	5/8"	43/64"	1/4"	5/8"	41/64"	3/32"	5/8"	5/8"	5/64"
27/32"	3/8"	3/4"	51/64"	19/64"	3/4"	49/64"	1/8"	3/4"	3/4"	3/32"
63/64"	7/16"	7/8"	15/16"	11/32"	7/8"	57/64"	9/64"	7/8"	7/8"	7/64"
1 1/8"	1/2"	1"	1 5/64"	13/32"	1"	1 1/64"	11/64"	1"	1"	1/8"
2 15/64"	1"	2"	2 5/32"	51/64"	2"	2 1/32"	21/64"	2"	2 1/64"	1/4"
3 23/64"	1 1/2"	3"	3 15/64"	1 13/64"	3"	3 3/64"	1/2"	3"	3 1/32"	3/8"
4 15/32"	2"	4"	4 5/16"	1 19/32"	4"	4 1/16"	43/64"	4"	4 1/32"	1/2"
5 19/32"	2 1/2"	5"	5 25/64"	2"	5"	5 1/16"	53/64"	5"	5 1/32"	5/8"
6 45/64"	3"	6"	6 15/32"	2 13/32"	6"	6 5/64"	1"	6"	6 3/64"	3/4"
7 53/64"	3 1/2"	7"	7 35/64"	2 51/64"	7"	7 3/32"	1 11/64"	7"	7 3/64"	7/8"
8 15/16"	4"	8"	8 5/8"	3 13/64"	8"	8 7/64"	1 21/64"	8"	8 1/16"	1"
10 1/16"	4 1/2"	9"	9 11/16"	3 19/32"	9"	9 1/8"	1 1/2"	9"	9 1/16"	1 1/8"
11 3/16"	5"	10"	10 49/64"	4"	10"	10 9/64"	1 43/64"	10"	10 5/64"	1 1/4"
12 19/64"	5 1/2"	11"	11 27/32"	4 13/32"	11"	11 5/32"	1 53/64"	11"	11 5/64"	1 3/8"
1′ 1 27/64"	6"	12"	12 59/64"	4 51/64"	12"	12 11/64"	2"	12"	12 3/32"	1 1/2"
2′ 2 53/64"	1′	2′	2′ 1 55/64"	9 19/32"	2′	2′ 0 21/64"	4"	2′	2′ 0 3/16"	3"
3′ 4 1/4"	1′ 6"	3′	3′ 2 25/32"	1′ 2 13/32"	3′	3′ 0 1/2"	6"	3′	3′ 0 9/32"	4 1/2"
4′ 5 43/64"	2′ 0"	4′	4′ 3 45/64"	1′ 7 13/64"	4′	4′ 0 21/32"	8"	4′	4′ 0 3/8"	6"
5′ 7 5/64"	2′ 6"	5′	5′ 4 5/8"	2′ 0"	5′	5′ 0 53/64"	10"	5′	5′ 0 15/32"	7 1/2"
6′ 8 1/2"	3′ 0"	6′	6′ 5 35/64"	2′ 4 51/64"	6′	6′ 0 63/64"	12"	6′	6′ 0 9/16"	9"
7′ 9 59/64"	3′ 6"	7′	7′ 6 15/32"	2′ 9 19/32"	7′	7′ 1 5/32"	1′ 2"	7′	7′ 0 21/32"	10 1/2"
8′ 11 21/64"	4′ 0"	8′	8′ 7 25/64"	3′ 2 13/32"	8′	8′ 1 21/64"	1′ 4"	8′	8′ 0 3/4"	1′
10′ 0 3/4"	4′ 6"	9′	9′ 8 5/16"	3′ 7 13/64"	9′	9′ 1 31/64"	1′ 6"	9′	9′ 0 27/32"	1′ 1 1/2"
11′ 2 11/64"	5′ 0"	10′	10′ 9 1/4"	4′ 0"	10′	10′ 1 21/32"	1′ 8"	10′	10′ 0 15/16"	1′ 3"
16′ 9 1/4"	7′ 6"	15′	16′ 1 55/64"	6′ 0"	15′	15′ 2 31/64"	2′ 6"	15′	15′ 1 13/32"	1′ 10 1/2"
22′ 4 21/64"	10′ 0"	20′	21′ 6 31/64"	8′ 0"	20′	20′ 3 5/16"	3′ 4"	20′	20′ 1 7/8"	2′ 6"
27′ 11 27/64"	12′ 6"	25′	26′ 11 7/64"	10′ 0"	25′	25′ 4 9/64"	4′ 2"	25′	25′ 2 11/32"	3′ 1 1/2"
33′ 6 1/2"	15′ 0"	30′	32′ 3 23/32"	12′ 0"	30′	30′ 4 31/32"	5′ 0"	30′	30′ 2 13/16"	3′ 9"
39′ 1 37/64"	17′ 6"	35′	37′ 8 11/32"	14′ 0"	35′	35′ 5 51/64"	5′ 10"	35′	35′ 3 9/32"	4′ 4 1/2"
44′ 8 21/32"	20′ 0"	40′	43′ 0 15/16"	16′ 0"	40′	40′ 6 5/8"	6′ 8"	40′	40′ 3 3/4"	5′ 0"
50′ 3 47/64"	22′ 6"	45′	48′ 5 19/32"	18′ 0"	45′	45′ 7 29/64"	7′ 6"	45′	45′ 4 7/32"	5′ 7 1/2"
55′ 10 53/64"	25′ 0"	50′	53′ 10 7/32"	20′ 0"	50′	50′ 8 9/32"	8′ 4"	50′	50′ 4 11/16"	6′ 3"

Intermediate lengths and lengths above those given in the table can ound by interpolation.

UNITED STATES STANDARD GAUGE FOR SHE AND PLATE IRON AND STEEL

Adopted as Standard by American Railway Master Mechanics As ciation and Association of American Steel Manufacturers.

Number of Gauge	Approximate Thickness in Fractions of an Inch	Approximate Thickness in Decimal Parts of an Inch	Approximate Thickness in Millimeters	Weight per Square Foot in Pounds Avoirdupois, Iron	Weight per Square Foot in Pounds Avoirdupois, Steel	Weight per Square Meter in Kilogrammes Steel	Number of
0000000	1—2	.5	12.70	20.	20.4	99.601	0000
000000	15—32	.46875	11.91	18.75	19.125	93.376	000
00000	7—16	.4375	11.11	17.50	17.85	87.151	00
0000	13—32	.40625	10.32	16.25	16.575	80.926	0
000	3—8	.375	9.53	15.	15.3	74.701	
00	11—32	.34375	8.73	13.75	14.025	68.476	
0	5—16	.3125	7.94	12.50	12.75	62.251	
1	9—32	.28125	7.14	11.25	11.475	56.026	
2	17—64	.265625	6.75	10.625	10.8375	52.913	
3	1—4	.25	6.35	10.	10.2	49.800	
4	15—64	.234375	5.95	9.375	9.5625	46.688	
5	7—32	.21875	5.56	8.75	8.925	43.575	
6	13—64	.203125	5.16	8.125	8.2875	40.463	
7	3—16	.1875	4.76	7.5	7.65	37.350	
8	11—64	.171875	4.37	6.875	7.0125	34.238	
9	5—32	.15625	3.97	6.25	6.375	31.125	
10	9—64	.140625	3.57	5.625	5.7375	28.013	
11	1—8	.125	3.18	5.	5.1	24.900	
12	7—64	.109375	2.78	4.375	4.4625	21.788	
13	3—32	.09375	2.38	3.75	3.825	18.675	
14	5—64	.078125	1.98	3.125	3.1875	15.563	
15	9—128	.0703125	1.79	2.8125	2.86875	14.006	
16	1—16	.0625	1.59	2.5	2.55	12.450	
17	9—160	.05625	1.43	2.25	2.295	11.205	
18	1—20	.05	1.27	2.	2.04	9.960	
19	7—160	.04375	1.11	1.75	1.785	8.715	
20	3—80	.0375	0.953	1.50	1.53	7.470	
21	11—320	.034375	0.873	1.375	1.4025	6.848	
22	1—32	.03125	0.794	1.25	1.275	6.225	
23	9—320	.028125	0.714	1.125	1.1475	5.603	
24	1—40	.025	0.635	1.	1.02	4.980	
25	7—320	.021875	0.556	.875	.8925	4.358	
26	3—160	.01875	0.476	.75	.765	3.735	
27	11—640	.0171875	0.437	.6875	.70125	3.424	
28	1—64	.015625	0.397	.625	.6375	3.113	
29	9—640	.0140625	0.357	.5625	.57375	2.801	
30	1—80	.0125	0.318	.5	.51	2.490	
31	7—640	.0109375	0.278	.4375	.44625	2.179	
32	13—1280	.01015625	0.258	.40625	.414375	2.023	
33	3—320	.009375	0.238	.375	.3825	1.868	
34	11—1280	.00859375	0.218	.34375	.350625	1.712	
35	5—640	.0078125	0.198	.3125	.31875	1.556	
36	9—1280	.00703125	0.179	.28125	.286875	1.401	
37	17—2560	.006640625	0.169	.265625	.2709375	1.323	
38	1—160	.00625	0.159	.25	.255	1.245	

STANDARD GAUGES

No. of Gauge	THICKNESS IN DECIMALS OF AN INCH							No. of Gauge
	Birmingham	Browne & Sharpe	United States Standard Plate Iron and Steel	British Imperial	American Steel & Wire Co.	Trenton Iron Co.	Stubs Steel Wire	
7°	.....	....	.500	.500	....	....	.....	7°
6°	.....	....	.46875	.464	....	....	.....	6°
5°	.....	....	.4375	.432	....	.45	.....	5°
4°	.454	.46	.40625	.400	.3938	.40	.....	4°
3°	.425	.40964	.375	.372	.3625	.36	.....	3°
2°	.380	.3648	.34375	.348	.3310	.33	.....	2°
0	.340	.32486	.3125	.324	.3065	.305	.....	0
1	.300	.2893	.28125	.300	.2830	.285	.227	1
2	.284	.25763	.265625	.276	.2625	.265	.219	2
3	.259	.22942	.25	.252	.2437	.245	.212	3
4	.238	.20431	.234375	.232	.2253	.225	.207	4
5	.220	.18194	.21875	.212	.2070	.205	.204	5
6	.203	.16202	.203125	.192	.1920	.190	.201	6
7	.180	.14428	.1875	.176	.1770	.175	.199	7
8	.165	.12849	.171875	.160	.1620	.160	.197	8
9	.148	.11443	.15625	.144	.1483	.145	.194	9
10	.134	.10189	.140625	.128	.1350	.130	.191	10
11	.120	.090742	.125	.116	.1205	.1175	.188	11
12	.109	.080808	.109375	.104	.1055	.1050	.185	12
13	.095	.071961	.09375	.092	.0915	.0925	.182	13
14	.083	.064084	.078125	.080	.0800	.0800	.180	14
15	.072	.057068	.0703125	.072	.0720	.0700	.178	15
16	.065	.05082	.0625	.064	.0625	.0610	.175	16
17	.058	.045257	.05625	.056	.0540	.0525	.172	17
18	.049	.040303	.05	.048	.0475	.0450	.168	18
19	.042	.03589	.04375	.040	.0410	.0400	.164	19
20	.035	.031961	.0375	.036	.0348	.0350	.161	20
21	.032	.028462	.034375	.032	.03175	.0310	.157	21
22	.028	.025347	.03125	.028	.0286	.0280	.155	22
23	.025	.022571	.028125	.024	.0258	.0250	.153	23
24	.022	.0201	.025	.022	.0230	.0225	.151	24
25	.020	.0179	.021875	.020	.0204	.0200	.148	25
26	.018	.01594	.01875	.018	.0181	.0180	.146	26
27	.016	.014195	.0171875	.0164	.0173	.0170	.143	27
28	.014	.012641	.015625	.0148	.0162	.0160	.139	28
29	.013	.011257	.0140625	.0136	.0150	.0150	.134	29
30	.012	.010025	.0125	.0124	.0140	.0140	.127	30
31	.010	.008928	.0109375	.0116	.0132	.0130	.120	31
32	.009	.00795	.01015625	.0108	.0128	.0120	.115	32
33	.008	.00708	.009375	.0100	.0118	.0110	.112	33
34	.007	.006304	.00859375	.0092	.0104	.0100	.110	34
35	.005	.005614	.0078125	.0084	.0095	.0095	.108	35
36	.004	.005	.00703125	.0076	.0090	.0090	.106	36
37	.....	.004453	.006640625	.0068	....	.0085	.103	37
38	.....	.003965	.00625	.0060	....	.0080	.101	38
39	.....	.003531	....	....	....	.0075	.099	39
40	.....	.003144	....	....	....	.0070	.097	40

MANUFACTURERS' STANDARD SPECIFICATIONS

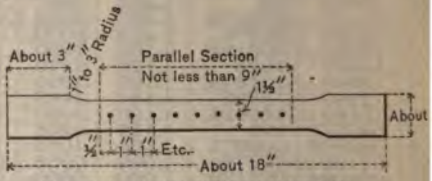
Revised February 6, 1903

STRUCTURAL STEEL

Process of Manufacture 1. Steel may be made by either the Open-hea[r
Bessemer process.

Testing and Inspection 2. All tests and inspections shall be made at the
of manufacture prior to shipment.

Test Pieces 3. The tensile strength, limit of elasticity and duc
shall be determined from a standard test piece cu
the finished material. The standard shape of th
piece for sheared plates shall be as shown by the f
ing sketch.



Piece to be of same thickness as the plate

On tests cut from other material the test piece r
either the same as for sheared plates, or it may be
or turned parallel throughout its entire length, an
cases where possible, two opposite sides of the tes
shall be the rolled surfaces. The elongation sh
measured on an original length of 8 inches exc
modified in section 12 paragraph *c*. Rivet roun
small bars shall be tested of full size as rolled.

Two test pieces shall be taken from each m
blow of finished material, one for tension and o
bending; but in case either test develops flaws,
tensile test piece breaks outside of the middle thir
gauged length, it may be discarded and another tes
substituted therefor.

Annealed Test Pieces 4. Material which is to be used without annea
further treatment shall be tested in the condition i
it comes from the rolls. When material is to be an
or otherwise treated before use, the specimen rep
ing such material shall be similarly treated before

5. Every finished piece of steel shall be stamped with the blow or melt number, and steel for pins shall have the blow or melt number stamped on the ends. Rivet and lacing steel, and small pieces for pin plates and stiffeners, may be shipped in bundles securely wired together, with the blow or melt number on a metal tag attached.

6. Finished bars shall be free from injurious seams, flaws or cracks, and have a workmanlike finish.

7a. Steel for Buildings, Train Sheds, Highway Bridges and similar structures.	Maximum Phosphorus .10 per cent.
7b. Steel for Railway Bridges.	Maximum Phosphorus .08 per cent.

8. Structural steel shall be of three grades, **Rivet, Railway Bridge** and **Medium.**

9. Ultimate strength, 48,000 to 58,000 pounds per square inch.

Elastic limit, not less than one-half the ultimate strength.

Percentage of elongation, $\frac{1,400,000}{\text{ultimate strength}}$.

Bending test, 180 degrees flat on itself, without fracture on outside of bent portion.

10. Ultimate strength, 55,000 to 65,000 pounds per square inch.

Elastic limit, not less than one-half the ultimate strength.

Percentage of elongation, $\frac{1,400,000}{\text{ultimate strength}}$.

Bending test, 180 degrees to a diameter equal to thickness of piece tested, without fracture on outside of bent portion.

11. Ultimate strength, 60,000 to 70,000 pounds per square inch.

Elastic limit, not less than one-half the ultimate strength.

Percentage of elongation, $\frac{1,400,000}{\text{ultimate strength}}$.

Bending test, 180 degrees to a diameter equal to thickness of piece tested, without fracture on outside of bent portion.

Modifications in Elongation for thin and thick material

12. For material less than $\frac{5}{16}$ inch and more than $\frac{3}{4}$ inch in thickness, the following modifications shall be made in the requirements for elongation:

a. For each increase of $\frac{1}{8}$ inch in thickness above $\frac{3}{4}$ inch, a deduction of 1 per cent. shall be made from the specified elongation, except that the minimum elongation shall be 20 per cent. for eye-bar material and 18 per cent. for other structural material.

b. For each decrease of $\frac{1}{16}$ inch in thickness below $\frac{5}{16}$ inch, a deduction of $2\frac{1}{2}$ per cent. shall be made from the specified elongation.

c. In rounds of $\frac{5}{8}$ inch or less in diameter, the elongation shall be measured in a length equal to eight times the diameter of section tested.

d. For pins made from any of the before-mentioned grades of steel, the required elongation shall be 5 per cent. less than that specified for each grade, as determined on a test piece, the center of which shall be one inch from the surface of the bar.

Variation in Weight

13. The variation in cross-section or weight of more than $2\frac{1}{2}$ per cent. from that specified will be sufficient cause for rejection, except in the case of sheared plates, which will be covered by the following permissible variations:

a. Plates $12\frac{1}{2}$ pounds per square foot or heavier, up to 100 inches wide, when ordered to weight, shall not average more than $2\frac{1}{2}$ per cent. variation above or $2\frac{1}{2}$ per cent. below the theoretical weight. When 100 inches wide and over, 5 per cent. above or 5 per cent. below the theoretical weight.

b. Plates under $12\frac{1}{2}$ pounds per square foot, when ordered to weight, shall not average a greater variation than the following:

Up to 75 inches wide, $2\frac{1}{2}$ per cent. above or $2\frac{1}{2}$ per cent. below the theoretical weight. 75 inches wide up to 100 inches wide, 5 per cent. above or 3 per cent. below the theoretical weight. When 100 inches wide and over, 10 per cent. above or 3 per cent. below the theoretical weight.

c. For all plates ordered to gauge, there will be permitted an average excess of weight over that corresponding to the dimensions on the order equal in amount to that specified in the following table:

TABLE OF ALLOWANCES FOR OVER-WEIGHT FOR RECTANGULAR PLATES WHEN ORDERED TO GAUGE

Plates will be considered up to gauge if measuring not over $\frac{1}{100}$ inch less than the ordered gauge.

The weight of 1 cubic inch of rolled steel is assumed to be 0.2833 pound.

PLATES ¼ INCH AND OVER IN THICKNESS

Thickness of Plate, inch	Width of Plate			
	Up to 75 inches Per cent.	75 to 100 inches Per cent.	Over 100 to 115 inches Per cent.	Over 115 inches Per cent.
¼	10	14	18	
$\frac{5}{16}$	8	12	16	
⅜	7	10	13	17
$\frac{7}{16}$	6	8	10	13
½	5	7	9	12
$\frac{9}{16}$	4½	6½	8½	11
⅝	4	6	8	10
Over ⅝	3½	5	6½	9

PLATES UNDER ¼ INCH IN THICKNESS

Thickness of Plate inch	Width of Plate		
	Up to 50 inches Per cent.	50 to 70 inches Per cent.	Over 70 inches Per cent.
⅛ up to $\frac{5}{32}$	10	15	20
$\frac{5}{32}$ up to $\frac{3}{16}$	8½	12½	17
$\frac{3}{16}$ up to ¼	7	10	15

STRUCTURAL CAST IRON

1. Except when chilled iron is specified, all castings shall be tough gray iron, free from injurious cold-shuts or blow-holes, true to pattern and of a workmanlike finish. Sample pieces, 1 inch square, cast from the same heat of metal in sand moulds, shall be capable of sustaining on a clear span of 4 feet 8 inches, a central load of 500 pounds when tested in the rough bar.

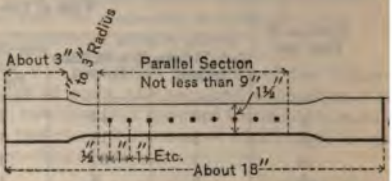
SPECIAL OPEN-HEARTH PLATE AN
RIVET STEEL

Testing and Inspection

1. All tests and inspections shall be made a of manufacture prior to shipment.

Test Pieces

2. The tensile strength, limit of elasticity an shall be determined from a standard test piec the finished material. The standard shape piece for sheared plates shall be as shown by ing sketch :



Piece to be of same thickness as the plate

On tests cut from other material the test pi either the same as for sheared plates, or it may or turned parallel throughout its entire lengt cases where possible, two opposite sides of th shall be the rolled surfaces. The elongatio measured on an original length of 8 inches, modified in section 12, paragraph *c*. Rivet r small bars shall be tested of full size as rolled.

Four test pieces shall be taken from ea finished material, two for tension and two fo but in case either test develops flaws, or the piece breaks outside of the middle third of length, it may be discarded and another test stituted therefor.

Annealed Test Pieces

3. Material which is to be used without an further treatment shall be tested in the conditi it comes from the rolls. When material is to b or otherwise treated before use, the specimen ing such material shall be similarly treated be

g 4. Every finished piece of steel shall be stamped with the melt number. Rivet steel may be shipped in bundles securely wired together, with the melt number on a metal tag attached.

5. All plates shall be free from injurious surface defects and have a workmanlike finish.

al ties

6*a*. Flange or Boiler Steel.	Maximum	Phosphorus	.06	per cent.
	"	Sulphur	.04	" "
6*b*. Extra soft and Fire Box Steel.	"	Phosphorus	.04	" "
	"	Sulphur	.04	" "

al ties 7. Special open hearth Plate and Rivet Steel shall be of three grades, **Extra Soft, Fire Box and Flange or Boiler Steel.**

Soft 8. Ultimate strength, 45,000 to 55,000 pounds per square inch.

Elastic limit, not less than one-half the ultimate strength.

Elongation, 28 per cent.

Cold and Quench bends, 180 degrees flat on itself, without fracture on outside of bent portion.

ox 9. Ultimate strength, 52,000 to 62,000 pounds per square inch.

Elastic limit, not less than one-half the ultimate strength.

Elongation, 26 per cent.

Cold and Quench bends, 180 degrees flat on itself, without fracture on outside of bent portion.

e or Steel 10. Ultimate strength, 55,000 to 65,000 pounds per square inch.

Elastic limit, not less than one-half the ultimate strength.

Elongation, 25 per cent.

Cold and Quench bends, 180 degrees flat on itself, without fracture on outside of bent portion.

Rivet 11. Steel for boiler rivets shall be made of the extra *soft grade* specified in paragraph No. 8.

Modifications in Elongation for thin and thick material

12. For material less than $\frac{5}{16}$ inch, and more
inch in thickness, the following modifications sh
made in the requirements for elongation:

a. For each increase of ⅛ inch in thickness a
inch, a deduction of 1 per cent. shall be made fr
specified elongation.

b. For each decrease of $\frac{1}{16}$ inch in thickness b
inch, a deduction of 2½ per cent. shall be made fr
specified elongation.

c. In rounds of ⅝ inch or less in diameter, the
tion shall be measured in a length equal to eigh
the diameter of section tested.

Variation in Weight

13. The variation in cross-section or weight o
than 2½ per cent. from that specified will be su
cause for rejection, except in the case of sheared
which will be covered by the following permissib
ations:

a. Plates 12½ pounds per square foot or heavie
100 inches wide, when ordered to weight, shall not a
more than 2½ per cent. variation above or 2½ pe
below the theoretical weight. When 100 inches wi
over, 5 per cent. above or 5 per cent. below the the
weight.

b. Plates under 12½ pounds per square foot
ordered to weight, shall not average a greater va
than the following:

Up to 75 inches wide, 2½ per cent. above or
cent. below the theoretical weight. 75 inches wid
100 inches wide, 5 per cent. above or 3 per cent. bel
theoretical weight. When 100 inches wide and o
per cent. above or 3 per cent. below the the
weight.

c. For all plates ordered to gauge there will
mitted an average excess of weight over that corre
ing to the dimensions on the order equal in amount
specified in the following table:

TABLE OF ALLOWANCES FOR OVER-WEIGHT FOR RECTANGULAR PLATES WHEN ORDERED TO GAUGE

Plates will be considered up to gauge if measuring not over $\frac{1}{100}$ inch less than the ordered gauge.

The weight of 1 cubic inch of rolled steel is assumed to be 0.2833 pound.

PLATES ¼ INCH AND OVER IN THICKNESS

Thickness of Plate, Inch	Width of Plate			
	Up to 75 inches Per cent.	75 to 100 inches Per cent.	Over 100 to 115 inches Per cent.	Over 115 inches Per cent.
¼	10	14	18	
$\frac{5}{16}$	8	12	16	
⅜	7	10	13	17
$\frac{7}{16}$	6	8	10	13
½	5	7	9	12
$\frac{9}{16}$	4½	6½	8½	11
⅝	4	6	8	10
Over ⅝	3½	5	6½	9

PLATES UNDER ¼ INCH IN THICKNESS

Thickness of Plate, inch	Width of Plate		
	Up to 50 inches Per cent.	50 to 70 inches Per cent.	Over 70 inches Per cent.
⅛ up to $\frac{5}{32}$	10	15	20
$\frac{5}{32}$ up to $\frac{3}{16}$	8½	12½	17
$\frac{3}{16}$ up to ¼	7	10	15

SPECIFICATIONS FOR WORKMAN

Inspection

1. Inspection of work shall be made as it prog
and at as early a period as the nature of the work p

2. All workmanship must be first-class. All a
surfaces of compression members, except flanges c
girders where the joints are fully spliced, must be
or turned to even bearings so that they shall be
contact throughout as may be obtained by such
All finished surfaces must be protected by white le
tallow.

3. The rivet holes for splice plates of abutting
bers shall be so accurately spaced that when the m
are brought into position the holes shall be truly c
before the rivets are driven.

4. Rollers must be finished perfectly round and
beds planed.

Rivets

5. The pitch of rivets in all classes of work shal
exceed 6 in., nor 16 times the thinnest outside plate
less than 3 diameters of the rivet. The rivets us
generally be ⅝, ¾ and ⅞ in. diameter. The distar
tween the edge of any piece and the center of a riv
must never be less than 1¼ in., except for bars le
2½ in. wide. When practicable it shall be at least 2
ters of the rivet. Rivets must completely fill th
have full heads concentric with the rivet, of a hei
less than .6 the diameter of the rivet, and in full
with the surface, or be countersunk when so requir
machine-driven wherever practicable.

Punching

6. The diameter of the punch shall not exceed b
than $\frac{1}{16}$ in. the diameter of the rivets to be used,
holes must be clean cuts without torn or ragged
Rivet holes must be accurately spaced; the use
pins will be allowed only for bringing together the
parts forming a member, and they must not be
with such force as to disturb the metal about the h

7. Built members must, when finished, be true a
from twists, kinks, buckles or open joints betw
component pieces.

-bars and -holes

8. All pin-holes must be accurately bored at right angles to the axis of the members, unless otherwise shown in the drawings, and in pieces not adjustable for length no variation of more than $\frac{1}{32}$ of an inch will be allowed in the length between centers of pin-holes; the diameter of the pin-holes shall not exceed that of the pins by more than $\frac{1}{32}$ in., nor by more than $\frac{1}{50}$ in. for pins under 3½ in. diameter. Eye-bars must be straight before boring; the holes must be in the center of the heads, and on the center line of the bars. Whenever eye-bars are to be packed more than ⅛ of an inch to the foot of their length out of parallel with the axis of the structure, they must be bent with a gentle curve until the head stands at right angles to the pin in their intended positions before being bored. All eye-bars belonging to the same panel, when placed in a pile, must allow the pin at each end to pass through at the same time without forcing. No welds will be allowed in the body of the bar of eye-bars, laterals or counters, except to form the loops of laterals, counters and sway rods; eyes of laterals, stirrups, sway rods and counters must be bored; pins and lateral bolts must be finished perfectly round and straight, and the party contracting to erect the work must provide pilot-nuts where necessary to preserve the threads while the pins are being driven. Thimbles or washers must be used whenever required to fill the vacant spaces on pins or bolts.

ot-nuts

nealing

9. In all cases where a steel piece in which the full strength is required has been partially heated the whole piece must be subsequently annealed. All bends in steel must be made cold, or if the degree of curvature is so great as to require heating, the whole piece must be subsequently annealed.

inting

10. All surfaces inaccessible after assembling must be well painted or oiled before the parts are assembled.

11. The decision of the engineer shall control as to the interpretation of drawings and specifications during the execution of work thereunder, but this shall not deprive the contractor of his right to redress, after the completion of the work, for an improper decision.

STANDARD SPECIFICATIONS FOR STEEL RAILS

(January 1, 1899)

Chemical Composition

1.

	50 lbs. up to 60 lbs.	60 lbs. up to 70 lbs.	70 lbs. up to 80 lbs.
Carbon.........	.35 to .45	.38 to .48	.40 to .50
Phosphorus.....	not over .10	not over .10	not over .10
Silicon..........	not over .20	not over .20	not over .20
Manganese.....	.70 to 1.00	.70 to 1.00	.75 to 1.05

	80 lbs. up to 90 lbs.	90 lbs. up to 100 lbs.
Carbon..........................	.43 to .53	.45 to .55
Phosphorus.....................	not over .10	not over .10
Silicon..........................	not over .20	not over .20
Manganese......................	.80 to 1.10	.80 to 1.10

Section

2. Unless otherwise specified, the section of rail shall be the American Standard, recommended by the American Society of Civil Engineers, and shall conform, as accurately as possible, to the templet furnished by the Railroad Company, consistent with Clause No. 3, relative to specified weight. An allowance in height of $\frac{1}{64}$ of an inch under and $\frac{1}{32}$ of an inch over, will be permitted. A perfect fit of the splice bars, however, shall be maintained at all times.

Weight

3. The weight of the rails shall be maintained as near as possible, after complying with Clause No. 2, to that specified in contract. A variation of ½ of 1 per cent. for an entire order will be allowed. Rails shall be accepted and settled for according to actual weight.

Length

4. The standard length of rails shall be 30 feet. Ten per cent. of the entire order will be accepted in shorter lengths, varying by even feet down to 24 feet. A variation of ¼ inch in length from the lengths specified will be allowed.

5. The name of the maker and the month and year of manufacture shall be rolled in raised letters on the side of the web, and the number of the heat shall be stamped on each rail.

6. Circular holes for splice bars shall be drilled in accordance with specifications of purchaser. They shall be accurate to drawing and dimensions furnished in every respect, and free from burrs.

7. Rails to be straightened while cold, to be smooth on head, to be sawed square at ends, and, prior to shipment, to have the burr occasioned by the saw cutting removed, and to have ends made clean. They are to be free from injurious defects and flaws of all kinds.

8. The inspector, representing the purchaser, shall have free access to the works of the manufacturer at all times while his contract is being executed, and shall have all reasonable facilities afforded to satisfy him that the rails are being made in accordance with specifications. The manufacturer shall furnish the inspector, daily, with carbon determinations of each heat, and a complete chemical analysis every twenty-four hours, representing the average of the other elements contained in the steel.

9. Rails which possess any injurious physical defects, or for any other cause are not suitable for first quality, shall be considered No. 2 Rails.

STANDARD SPECIFICATIONS
STEEL SPLICE BARS

(January 1, 1899)

Chemical Composition

1. Carbon, not to exceed........... 0.1
   Phosphorus, not to exceed...... 0.1
   Manganese.......................0.40 to 0.(

Physical Properties

2. Test pieces cut from head of splice bar n

a. Ultimate strength, 54,000 to 64,000 lbs.]
inch.

b. Elastic limit, not less than one-half th
strength.

c. Elongation, not less than 25 per cent. me
in. (203 millimeters).

d. Bending test, 180 degrees flat on itself wi
ture on outside of bent portion.

Finish

3. All splice bars shall be smoothly rolled ;
templet. The name of maker and year of m
shall be rolled in raised letters on the side (
The bars shall be sheared accurately to lengtl
from fins or cracks, and shall be perfect fit to t
which they are intended.

nanship

4. The punching and notching of Splice Bars must be accurate in every respect to drawing and dimensions furnished.

tion

5. The inspector, representing the purchaser, shall have free access to the works of the manufacturer at all times while his contract is being executed, and shall have all reasonable facilities afforded to satisfy him that splice bars are being made in accordance with specifications.

NOTES ON STEEL AND IRON

1. The average weight of wrought iron is 480 lbs. per cubic fo
bar 1 inch square and 3 feet long weighs, therefore, exactly 1
Hence:

To find the sectional area, given the weight per foot:
Multiply by $\frac{3}{10}$.

To find the weight per foot, given the sectional area:
Multiply by $\frac{10}{3}$.

2. The weight of steel is 2 per cent. greater than that of wrough
To find sectional area, given weight per foot:
Divide by 3.4.
To find weight per foot, given sectional area:
Multiply by 3.4.

3. The center load at which a bar of wrought iron 1 in. squar
12 in. center to center of points of support, will give way is very
one ton (of 2,240 lbs.).

4. Within the elastic limit the extension and compression of wr
iron is very nearly $\frac{1}{10000}$ of its length for a stress of *one ton* (of 2,2
per square inch.

For cast iron this ratio is $\frac{1}{5000}$ for tension, but becomes varia
compression.

5. The contraction or expansion of wrought iron under chan
temperature is about $\frac{1}{10000}$ of its length, for a variation of 15° Fahr
The stress thus induced, if the ends are held rigidly fixed,
about *one ton* (of 2,240 lbs.) per square inch of cross-section.

6. The coefficient of expansion of wrought iron for 100° Fahr
is 0.000686. Therefore, for a variation in temperature of 125°, a
wrought iron 100 feet long will expand or contract 1.029 inches.

Conversely: A change in length of 1 inch per hundred feet wo
produced by a variation in temperature of 121.5° Fahrenheit.

7. The melting point of iron and steel is about as follows:

Wrought iron, ...	3,000° Fahrenheit
Cast iron, ...	2,000° "
Steel, ...	2,400° "

8. The welding heat of wrought iron is 2,733° Fahrenheit.

MISCELLANEOUS NOTES

1. Thrust of arch per lineal foot:

$T = \frac{1.5\,wl^2}{r}$, in which w = load per square foot, r = rise i
in inches, and l = span in feet.

2. *Approximately the radius of gyration for a box section i*
least side.

LOADS UNIFORMLY DISTRIBUTED FOR RECTANGULAR SPRUCE OR WHITE PINE BEAMS ONE INCH THICK

following table has been calculated for extreme fiber stresses lbs. per square inch corresponding to the following values for of Rupture recommended by Prof. Lanza, viz.:

Spruce and white pine........................3,000 lbs.
Oak...4,000 "
Yellow pine....................................5,000 "

oak increase values in table by ⅓. For yellow pine increase in table by ⅔.

safe load for any other values per square inch is found by ing or decreasing the loads given in the table in the same pro- as the increased or decreased fiber stress.

Depth of Beam										
6"	7"	8"	9"	10"	11"	12"	13"	14"	15"	16"
600	820	1070	1350	1670	2020	2400	2820	3270	3750	4270
500	680	890	1120	1390	1680	2000	2350	2730	3120	3560
430	580	760	960	1190	1440	1710	2010	2330	2680	3050
380	510	670	840	1040	1260	1500	1760	2040	2340	2670
330	460	590	750	930	1120	1330	1560	1810	2080	2370
300	410	530	670	830	1010	1200	1410	1630	1880	2130
270	370	490	610	760	920	1090	1280	1490	1710	1940
250	340	440	560	690	840	1000	1180	1360	1560	1780
230	310	410	520	640	780	930	1080	1260	1440	1640
210	290	380	480	590	720	860	1010	1170	1340	1530
200	270	360	450	560	670	800	940	1090	1250	1420
190	260	330	420	520	630	750	880	1020	1180	1330
180	240	310	400	490	590	710	830	960	1100	1260
170	230	290	370	460	560	670	780	910	1040	1190
160	210	280	360	440	530	630	740	860	990	1130
150	200	270	340	420	510	600	710	820	940	1070
140	190	260	320	390	480	570	670	780	890	1020
140	190	240	310	380	460	540	640	740	850	970
130	180	230	290	360	440	520	610	710	810	920
130	170	220	280	350	420	500	590	680	780	890
120	160	210	270	330	410	480	560	660	750	860
110	160	210	260	320	390	460	540	630	720	820
110	150	200	250	310	370	440	520	610	690	790
110	140	190	240	300	360	430	500	580	670	760
110	140	180	230	290	350	410	490	560	640	740

obtain the safe load for any thickness: Multiply values for 1 inch kness of beam.
obtain *the required thickness* for any load: Divide by safe load *ch.*

SAFE LOADS FOR RECTANGULAR WO
PILLARS (SEASONED)

l = length of pillar in inches.
d = width of smallest side in inches.

Yellow Pine (Southern)	White Oak	White Pi
$\dfrac{1125}{1+\dfrac{l^2}{1100d^2}}$	$\dfrac{925}{1+\dfrac{l^2}{1100d^2}}$	$1+$

These formulæ give safe loads of one-forth the ultima
for short pillars decreasing to one-fifth the ultimate for l

Ratio of Length to Least Side $\frac{l}{d}$	Safe Load in Pounds per Square Inch of Sectio	
	Yellow Pine (Southern)	White Oak
12	995	818
14	955	785
16	913	750
18	869	715
20	825	678
22	781	642
24	738	607
26	697	575
28	657	541
30	619	509
32	583	479
34	549	451
36	516	425
38	487	400
40	458	377

SAFE LOADS IN TONS OF 2,000 LBS. FOR SQUARE WOODEN PILLARS

Unsupported Length of Column in Feet	Size of Pillar in Inches						
	6x6	8x8	9x9	10x10	12x12	14x14	16x16
	WHITE PINE OR SPRUCE						
6	12.80						
8	11.70	22.7	29.6				
10	10.60	21.3	28.0	35.5			
12	9.54	19.8	26.3	33.7	51.1		
14	8.46	18.4	24.7	31.9	49.0	69.6	
16	7.38	17.0	23.1	30.1	46.8	67.0	91.0
18	....	15.5	21.5	28.3	44.7	64.5	88.0
20	....	14.1	19.8	26.5	42.5	62.0	85.2
22	....	....	18.2	24.7	40.3	59.5	82.3
24	....	....	....	22.9	38.2	57.0	79.4
	WHITE OAK						
6	14.80						
8	13.50	26.2	34.0				
10	12.20	24.6	32.4	41.0			
12	11.00	22.7	30.4	39.1	59.1		
14	9.73	21.1	28.4	36.7	56.9	80.4	
16	8.64	19.5	26.5	34.6	54.0	77.8	105.0
18	....	17.8	24.7	32.4	51.1	74.5	102.0
20	....	16.3	22.7	30.5	49.0	71.3	98.5
22	....	....	21.1	28.2	46.1	68.3	94.7
24	....	....	....	26.4	43.9	65.5	90.9
	YELLOW PINE (SOUTHERN)						
6	18.0						
8	16.4	32.0	41.6				
10	14.9	29.9	39.4	50.0			
12	13.3	27.8	36.9	47.6	72.0		
14	11.9	25.8	34.7	44.7	69.1	98.0	132.0
16	10.4	23.7	32.3	42.3	65.5	94.6	128.0
18	....	21.8	30.0	39.5	62.6	90.7	124.0
20	....	19.8	27.8	37.0	59.8	86.9	120.0
22	....	....	25.7	34.6	56.2	83.6	115.0
24	....	....	....	32.2	53.3	80.0	111.0

STRENGTH OF MATERIALS

ULTIMATE RESISTANCE TO TENSION IN LBS. PER SQUARE

METALS AND ALLOYS

Aluminum Bronze

10 per cent. Al. and 90 per cent. Copper . . . . . .

1¼ " " 98¾ " " . . . . . .

Brass, cast . . . .

" wire . . . .

Bronze or gun metal . . . .

Copper, cast . . . .

" sheet . . . .

" bolts . . . .

" wire (unannealed) . . . .

Iron, cast, 13,400 to 29,000 . . . .

" wire, black or annealed . . . .

" " bright hard drawn . . . .

Lead, sheet . . . .

Steel . . . . **45000** to 1

" Aluminum 2½ per cent. Aluminum . . . . . .

" Copper, 35 per cent. Copper . . . .

" Nickel, 3¼ per cent. Nickel . . . .

" cast, wire, crucible 2

" " Bessemer . . . .

" " high carbon 1

" " mild O. H. 1

The modulus of elasticity of steel from recent tests is from 2 to 31,000,000. Average, 29,000,000.

Tin, cast . . . .

Zinc 7000

RENGTH OF MATERIALS—Continued

R, SEASONED, AND OTHER ORGANIC FIBER

largely from Trautwine's pocket book (edition of 1891)

	Average
. . . .	16000
ın	16500
sh	11500
. . . .	15000
·anon	11400
can, red	10300
ᴈ	10000
›es	12000 to 16000
ıerican	11000
. . . .	8000
an, white	10000
an	10000
:an, white, red and pitch, Memel, Riga	10000
long leaf yellow	12600 to 19200
. . . .	7000
. . . .	20000
k	8000

STONE, NATURAL AND ARTIFICIAL

ment	280 to 300
. . . .	2560
. . . .	2400 to 4600
ıary lime	10 to 20

ULTIMATE RESISTANCE TO COMPRESSION

METALS

. . . .	10300
. . . .	85000 to 12500[illegible]
. . . .	45000 to 12000[illegible]

STRENGTH OF MATERIALS—Continued

TIMBER, SEASONED, COMPRESSED IN THE DIRECTION OF THE GRAIN

Taken largely from Trautwine's pocket book (edition of 1891)

Ash, American	
Beech "	
Birch	
Cedar of Lebanon	
" American, red	
Chestnut	
Deal, red	
Fir or Spruce	
Hickory	
Oak, American, white	
" British	1
" Dantzig	
Pine, American, white	
" " long leaf yellow	
Walnut, black	

STONE, NATURAL AND ARTIFICIAL

Brick, weak	550 t
" strong	
" fire	
Brick work, ordinary, in cement	300 t
" best	
Glass	3
Granite	5000 to 1
Limestone	4000 to 1
Sandstone, ordinary	2500 to 1

ULTIMATE RESISTANCE TO SHEARING

METALS

Iron, cast	2
Steel	5

TIMBER, SEASONED, ALONG THE GRAIN

White Pine, Spruce, Hemlock	250 t
Yellow Pine, long leaf	300 t
Oak	400

:CIFIC GRAVITY OF VARIOUS SUBSTANCES

.mes of Substances	Specific Gravity
um { cast	2.60
um { hammered	2.75
	1.08
:ite	1.40-1.70
:um	1.10-1.20
	0.85
:ast	8.40-8.70
rolled	8.57
ommon, hard	1.53-2.30
, ground, loose	1.85
ıl	0.44
dry	0.76-0.84
'y	1.80-2.60
tuminous	1.20-1.50
·ose	0.55
e	2.47
{ cast	8.79
{ rolled	8.78-9.00
d	3.52
ıumus	1.30-1.80
ommon window	2.64
common	2.40-2.70
ast, pure or 24 carat	19.28
ure hammered	19.33
	2.50-3.00
ı, cast, dry	0.97
:nde	3.00
	0.88-0.92
ıst	7.10-7.50
rought	7.79
	1.82
	11.37
	2.30-3.20
acked	1.30-1.40
nes	2.46-2.84

Names of Substances	Specific Gravity
Magnesium	1.74
Mahogany	0.56-1.09
Maple, dry	0.70
Marble	2.52-2.85
Masonry, stone, dry	2.00-2.55
" brick, "	1.50-1.60
Mercury, a. 32° Fah.	13.596
Mica	2.80
Oak, dry	0.69-1.03
Petroleum, at 59° Fah.	0.80
Pine	0.35-0.60
Platinum { cast	21.15
Platinum { hammered	21.3-21.5
Quartz	2.5-2.80
Saltpetre, Chili	2.26
" Kali	1.95-2.08
Sand, fine, dry	1.40-1.65
" wet	1.90-2.05
" coarse	1.40-1.50
Sandstone	2.20-2.50
Silver { cast	10.48
Silver { hammered	10.62
Slate	2.60-2.70
Snow, freshly fallen	0.19
Steel	7.26-7.86
Sulphur	1.98-2.07
Sodium	0.978
Tin { cast	7.20
Tin { rolled	7.30
Water { pure rain or distilled, at 39° Fah.	1.00
" sea	1.02
Walnut, dry	0.60 0.81
Wax	0.95-0.98
Zinc { cast	[illegible]
Zinc { rolled	[illegible]

WEIGHT OF A CUBIC FOOT OF SUBSTANCES

Names of Substances	Aver. Wei. lb
Aluminum	1
Anthracite, solid, of Pennsylvania	
" broken, loose	
" " moderately shaken	
" heaped bushel, loose	(
Ash, American, white, dry	
Asphaltum	
Brass (Copper and Zinc), cast	5
" rolled	5
Brick, best pressed	1
" common, hard	1
" soft, inferior	1
Brickwork, pressed brick	1
" ordinary	1
Cement, hydraulic, ground, loose, American Rosendale . .	
" " " " " Louisville . .	
" " " " English, Portland . . .	
Cherry, dry	
Chestnut, dry	
Clay, potters', dry	1
" in lump, loose	
Coal, bituminous, solid	
" " broken, loose	
" " heaped bushel, loose	(
Coke, loose, of good coal	2
" " heaped bushel	(
Copper, cast	5
" rolled	5
Earth, common loam, dry, loose	
" " " " moderately rammed . . .	
" as a soft flowing mud	1
Ebony, dry	
Elm, dry	
. . . .	

VEIGHT OF SUBSTANCES—Continued

Names of Substances	Average Weight, Lbs.
mon window	157
nmon	168
pure, or 24 carat	1204
, hammered	1217
0 lbs. per bushel	48
	170
out the same as sand, which see.	
›laster of paris)	142
dry	25
lry	53
le, black	203
	58.7
	450
ght, purest	485
average	480
	114
	711
itæ, dry	83
k, ground, loose, or in small lumps	53
" " thoroughly shaken	75
" " per struck bushel	(66)
s and marbles	168
" loose, in irregular fragments	96
n	109
, Spanish, dry	53
Honduras, dry	35
	49
ee Limestones.	
of granite or limestone, well dressed	165
" mortar rubble	154
" dry " (well scabbled)	138
" sandstone, well dressed	144
ıt 32° Fahrenheit	849
	18[illegible]
rdened	10[illegible]
close	80 to 1[illegible]
fluid, maximum	1[illegible]
ry	

WEIGHT OF SUBSTANCES—Continued

Names of Substances	Ave Wei Lb
Oak, white, dry	
" other kinds	32 to
Petroleum	
Pine, white, dry	
" yellow, Northern	
" " Southern	
Platinum	1
Quartz, common, pure	
Rosin	
Salt, coarse, Syracuse, N. Y.	
" Liverpool, fine, for table use	
Sand, of pure quartz, dry, loose	90 to
" well shaken	99 to
" perfectly wet	120 to
Sandstones, fit for building	
Shales, red or black	
Silver	
Slate	
Snow, freshly fallen	5 t
" moistened and compacted by rain	15 t
Spruce, dry	
Steel	
Sulphur	
Sycamore, dry	
Tar	
Tin, cast	
Turf or Peat, dry, unpressed	20 t
Walnut, black, dry	
Water, pure rain or distilled, at 60° Fahrenheit	
" sea	
Wax, bees	
Zinc or Spelter	4

Green timbers usually weigh from one-fifth to one-half more than

:AR EXPANSION OF SUBSTANCES BY HEAT

the increase in the length of a bar of any material
ncrease of temperature, multiply the number of
increase of temperature by the coefficient for 100
by the length of the bar and divide by 100.

ne of Substance	Coefficient for 100° Fahrenheit	Coefficient for 180° Fahrenheit, or 100° Centigrade
the direction of the)	.00026 TO .00031	.00046 TO .00057
	.00104	.00188
	.00107	.00193
	.0003	.0005
an)	.0008	.0014
	.0009	.0017
lirection of the grain,	.00024	.00044
ı flint)	.00045	.00081
white lead)	.00048	.00087
	.0008	.0015
age)	.00047	.00085
	.0006	.0011
ged)	.0007	.0012
	.0008	.0014
	.0016	.0029
ıra)	.00036 TO .0006	.00065 TO .0011
	.0033	.0060
	.0005	.0009
	.0005 TO .0007	.0009 TO .0012
	.0011	.002
	.0006	.001
considerably with the ıre)	.0086	.0155

AREAS OF FLAT ROLLED STEEL

For Thicknesses from $\frac{1}{16}$ in. to 2 in. and Widths from 1 in. to 12¾ i

Thickness in Inches	1″	1¼″	1½″	1¾″	2″	2¼″	2½″	2¾″
$\frac{1}{16}$	.063	.078	.094	.109	.125	.141	.156	.172
⅛	.125	.156	.188	.219	.250	.281	.313	.344
$\frac{3}{16}$	.188	.234	.281	.328	.375	.422	.469	.516
¼	.250	.313	.375	.438	.500	.563	.625	.688
$\frac{5}{16}$	.313	.391	.469	.547	.625	.703	.781	.859
⅜	.375	.469	.563	.656	.750	.844	.938	1.03
$\frac{7}{16}$	.438	.547	.656	.766	.875	.984	1.09	1.20
½	.500	.625	.750	.875	1.00	1.13	1.25	1.38
$\frac{9}{16}$	.563	.703	.844	.984	1.13	1.27	1.41	1.55
⅝	.625	.781	.938	1.09	1.25	1.41	1.56	1.72
$\frac{11}{16}$	.688	.859	1.03	1.20	1.38	1.55	1.72	1.89
¾	.750	.938	1.13	1.31	1.50	1.69	1.88	2.06
$\frac{13}{16}$	.813	1.02	1.22	1.42	1.63	1.83	2.03	2.23
⅞	.875	1.09	1.31	1.53	1.75	1.97	2.19	2.41
$\frac{15}{16}$	.938	1.17	1.41	1.64	1.88	2.11	2.34	2.58
1	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75
$1\frac{1}{16}$	1.06	1.33	1.59	1.86	2.13	2.39	2.66	2.92
1⅛	1.13	1.41	1.69	1.97	2.25	2.53	2.81	3.09
$1\frac{3}{16}$	1.19	1.48	1.78	2.08	2.38	2.67	2.97	3.27
1¼	1.25	1.56	1.88	2.19	2.50	2.81	3.13	3.44
$1\frac{5}{16}$	1.31	1.64	1.97	2.30	2.63	2.95	3.28	3.61
1⅜	1.38	1.72	2.06	2.41	2.75	3.09	3.44	3.78
$1\frac{7}{16}$	1.44	1.80	2.16	2.52	2.88	3.23	3.59	3.95
1½	1.50	1.88	2.25	2.63	3.00	3.38	3.75	4.13
$1\frac{9}{16}$	1.56	1.95	2.34	2.73	3.13	3.52	3.91	4.30
1⅝	1.63	2.03	2.44	2.84	3.25	3.66	4.06	4.47
$1\frac{11}{16}$	1.69	2.11	2.53	2.95	3.38	3.80	4.22	4.64
1¾	1.75	2.19	2.63	3.06	3.50	3.94	4.38	4.81
$1\frac{13}{16}$	1.81	2.27	2.72	3.17	3.63	4.08	4.53	4.98
1⅞	1.88	2.34	2.81	3.28	3.75	4.22	4.69	5.16
$1\frac{15}{16}$	1.94	2.42	2.91	3.39	3.88	4.36	4.84	5.33
2	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50

AREAS OF FLAT ROLLED STEEL—Continued

3″	3¼″	3½″	3¾″	4″	4¼″	4½″	4¾″	12″
.188	.203	.219	.234	.250	.266	.281	.297	.750
.375	.406	.438	.469	.500	.531	.563	.594	1.50
.563	.609	.656	.703	.750	.797	.844	.891	2.25
.750	.813	.875	.938	1.00	1.06	1.13	1.19	3.00
.938	1.02	1.09	1.17	1.25	1.33	1.41	1.48	3.75
1.13	1.22	1.31	1.41	1.50	1.59	1.69	1.78	4.50
1.31	1.42	1.53	1.64	1.75	1.86	1.97	2.08	5.25
1.50	1.63	1.75	1.88	2.00	2.13	2.25	2.38	6.00
1.69	1.83	1.97	2.11	2.25	2.39	2.53	2.67	6.75
1.88	2.03	2.19	2.34	2.50	2.66	2.81	2.97	7.50
2.06	2.23	2.41	2.58	2.75	2.92	3.09	3.27	8.25
2.25	2.44	2.63	2.81	3.00	3.19	3.38	3.56	9.00
2.44	2.64	2.84	3.05	3.25	3.45	3.66	3.86	9.75
2.63	2.84	3.06	3.28	3.50	3.72	3.94	4.16	10.50
2.81	3.05	3.28	3.52	3.75	3.98	4.22	4.45	11.25
3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	12.00
3.19	3.45	3.72	3.98	4.25	4.52	4.78	5.05	12.75
3.38	3.66	3.94	4.22	4.50	4.78	5.06	5.34	13.50
3.56	3.86	4.16	4.45	4.75	5.05	5.34	5.64	14.25
3.75	4.06	4.38	4.69	5.00	5.31	5.63	5.94	15.00
3.94	4.27	4.59	4.92	5.25	5.58	5.91	6.23	15.75
4.13	4.47	4.81	5.16	5.50	5.84	6.19	6.53	16.50
4.31	4.67	5.03	5.39	5.75	6.11	6.47	6.83	17.25
4.50	4.88	5.25	5.63	6.00	6.38	6.75	7.13	18.00
4.69	5.08	5.47	5.86	6.25	6.64	7.03	7.42	18.75
4.88	5.28	5.69	6.09	6.50	6.91	7.31	7.72	19.50
5.06	5.48	5.91	6.33	6.75	7.17	7.59	8.02	20.25
5.25	5.69	6.13	6.56	7.00	7.44	7.88	8.31	21.00
5.44	5.89	6.34	6.80	7.25	7.70	8.16	8.61	21.75
5.63	6.09	6.56	7.03	7.50	7.97	8.44	8.91	22.50
5.81	6.30	6.78	7.27	7.75	8.23	8.72	9.20	23.25
6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	24.00

AREAS OF FLAT ROLLED STEEL—Contin

Thickness in Inches	5"	5¼"	5½"	5¾"	6"	6¼"	6½"	6¾"
$\frac{1}{16}$	.313	.328	.344	.359	.375	.391	.406	.422
⅛	.625	.656	.688	.719	.750	.781	.813	.844
$\frac{3}{16}$	.938	.984	1.03	1.08	1.13	1.17	1.22	1.27
¼	1.25	1.31	1.38	1.44	1.50	1.56	1.63	1.69
$\frac{5}{16}$	1.56	1.64	1.72	1.80	1.88	1.95	2.03	2.11
⅜	1.88	1.97	2.06	2.16	2.25	2.34	2.44	2.53
$\frac{7}{16}$	2.19	2.30	2.41	2.52	2.63	2.73	2.84	2.95
½	2.50	2.63	2.75	2.88	3.00	3.13	3.25	3.38
$\frac{9}{16}$	2.81	2.95	3.09	3.23	3.38	3.52	3.66	3.80
⅝	3.13	3.28	3.44	3.59	3.75	3.91	4.06	4.22
$\frac{11}{16}$	3.44	3.61	3.78	3.95	4.13	4.30	4.47	4.64
¾	3.75	3.94	4.13	4.31	4.50	4.69	4.88	5.06
$\frac{13}{16}$	4.06	4.27	4.47	4.67	4.88	5.08	5.28	5.48
⅞	4.38	4.59	4.81	5.03	5.25	5.47	5.69	5.91
$\frac{15}{16}$	4.69	4.92	5.16	5.39	5.63	5.86	6.09	6.33
1	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75
$1\frac{1}{16}$	5.31	5.58	5.84	6.11	6.38	6.64	6.91	7.17
1⅛	5.63	5.91	6.19	6.47	6.75	7.03	7.31	7.59
$1\frac{3}{16}$	5.94	6.23	6.53	6.83	7.13	7.42	7.72	8.02
1¼	6.25	6.56	6.88	7.19	7.50	7.81	8.13	8.44
$1\frac{5}{16}$	6.56	6.89	7.22	7.55	7.88	8.20	8.53	8.86
1⅜	6.88	7.22	7.56	7.91	8.25	8.59	8.94	9.28
$1\frac{7}{16}$	7.19	7.55	7.91	8.27	8.63	8.98	9.34	9.70
1½	7.50	7.88	8.25	8.63	9.00	9.38	9.75	10.13
$1\frac{9}{16}$	7.81	8.20	8.59	8.98	9.38	9.77	10.16	10.55
1⅝	8.13	8.53	8.94	9.34	9.75	10.16	10.56	10.97
$1\frac{11}{16}$	8.44	8.86	9.28	9.70	10.13	10.55	10.97	11.39
1¾	8.75	9.19	9.63	10.06	10.50	10.94	11.38	11.81
$1\frac{13}{16}$	9.06	9.52	9.97	10.42	10.88	11.33	11.78	12.23
1⅞	9.38	9.84	10.31	10.78	11.25	11.72	12.19	12.66
$1\frac{15}{16}$	9.69	10.17	10.66	11.14	11.63	12.11	12.59	13.08
2	10.00	10.50	11.00	11.50	12.00	12.50	13.00	13.50

AREAS OF FLAT ROLLED STEEL—Continued

in Inches	7"	7¼"	7½"	7¾"	8"	8¼"	8½"	8¾"	12"
1/16	.438	.453	.469	.484	.500	.516	.531	.547	.750
1/8	.875	.906	.938	.969	1.00	1.03	1.06	1.09	1.50
3/16	1.31	1.36	1.41	1.45	1.50	1.55	1.59	1.64	2.25
1/4	1.75	1.81	1.88	1.94	2.00	2.06	2.13	2.19	3.00
5/16	2.19	2.27	2.34	2.42	2.50	2.58	2.66	2.73	3.75
3/8	2.63	2.72	2.81	2.91	3.00	3.09	3.19	3.28	4.50
7/16	3.06	3.17	3.28	3.39	3.50	3.61	3.72	3.83	5.25
1/2	3.50	3.63	3.75	3.88	4.00	4.13	4.25	4.38	6.00
9/16	3.94	4.08	4.22	4.36	4.50	4.64	4.78	4.92	6.75
5/8	4.38	4.53	4.69	4.84	5.00	5.16	5.31	5.47	7.50
11/16	4.81	4.98	5.16	5.33	5.50	5.67	5.84	6.02	8.25
3/4	5.25	5.44	5.63	5.81	6.00	6.19	6.38	6.56	9.00
13/16	5.69	5.89	6.09	6.30	6.50	6.70	6.91	7.11	9.75
7/8	6.13	6.34	6.56	6.78	7.00	7.22	7.44	7.66	10.50
15/16	6.56	6.80	7.03	7.27	7.50	7.73	7.97	8.20	11.25
	7.00	7.25	7.50	7.75	8.00	8.25	8.50	8.75	12.00
1/16	7.44	7.70	7.97	8.23	8.50	8.77	9.03	9.30	12.75
1/8	7.88	8.16	8.44	8.72	9.00	9.28	9.56	9.84	13.50
3/16	8.31	8.61	8.91	9.20	9.50	9.80	10.09	10.39	14.25
1/4	8.75	9.06	9.38	9.69	10.00	10.31	10.63	10.94	15.00
5/16	9.19	9.52	9.84	10.17	10.50	10.83	11.16	11.48	15.75
3/8	9.63	9.97	10.31	10.66	11.00	11.34	11.69	12.03	16.50
7/16	10.06	10.42	10.78	11.14	11.50	11.86	12.22	12.58	17.25
1/2	10.50	10.88	11.25	11.63	12.00	12.38	12.75	13.13	18.00
9/16	10.94	11.33	11.72	12.11	12.50	12.89	13.28	13.67	18.75
5/8	11.38	11.78	12.19	12.59	13.00	13.41	13.81	14.22	19.50
11/16	11.81	12.23	12.66	13.08	13.50	13.92	14.34	14.77	20.25
3/4	12.25	12.69	13.13	13.56	14.00	14.44	14.88	15.31	21.00
1 13/16	12.69	13.14	13.59	14.05	14.50	14.95	15.41	15.86	21.75
1 7/8	13.13	13.59	14.06	14.53	15.00	15.47	15.94	16.41	22.50
1 15/16	13.56	14.05	14.53	15.02	15.50	15.98	16.47	16.95	23.25
2	14.00	14.50	15.00	15.50	16.00	16.50	17.00	17.50	24.00

AREAS OF FLAT ROLLED STEEL—C

Thickness in Inches	9″	9¼″	9½″	9¾″	10″	10¼″	10½″
1/16	.563	.578	.594	.609	.625	.641	.656
1/8	1.13	1.16	1.19	1.22	1.25	1.28	1.31
3/16	1.69	1.73	1.78	1.83	1.88	1.92	1.97
1/4	2.25	2.31	2.38	2.44	2.50	2.56	2.63
5/16	2.81	2.89	2.97	3.05	3.13	3.20	3.28
3/8	3.38	3.47	3.56	3.66	3.75	3.84	3.94
7/16	3.94	4.05	4.16	4.27	4.38	4.48	4.59
1/2	4.50	4.63	4.75	4.88	5.00	5.13	5.25
9/16	5.06	5.20	5.34	5.48	5.63	5.77	5.91
5/8	5.63	5.78	5.94	6.09	6.25	6.41	6.56
11/16	6.19	6.36	6.53	6.70	6.88	7.05	7.22
3/4	6.75	6.94	7.13	7.31	7.50	7.69	7.88
13/16	7.31	7.52	7.72	7.92	8.13	8.33	8.53
7/8	7.88	8.09	8.31	8.53	8.75	8.97	9.19
15/16	8.44	8.67	8.91	9.14	9.38	9.61	9.84
1	9.00	9.25	9.50	9.75	10.00	10.25	10.50
1 1/16	9.56	9.83	10.09	10.36	10.63	10.89	11.16
1 1/8	10.13	10.41	10.69	10.97	11.25	11.53	11.81
1 3/16	10.69	10.98	11.28	11.58	11.88	12.17	12.47
1 1/4	11.25	11.56	11.88	12.19	12.50	12.81	13.13
1 5/16	11.81	12.14	12.47	12.80	13.13	13.45	13.78
1 3/8	12.38	12.72	13.06	13.41	13.75	14.09	14.44
1 7/16	12.94	13.30	13.66	14.02	14.38	14.73	15.09
1 1/2	13.50	13.88	14.25	14.63	15.00	15.38	15.75
1 9/16	14.06	14.45	14.84	15.23	15.63	16.02	16.41
1 5/8	14.63	15.03	15.44	15.84	16.25	16.66	17.06
1 11/16	15.19	15.61	16.03	16.45	16.88	17.30	17.72
1 3/4	15.75	16.19	16.63	17.06	17.50	17.94	18.38
1 13/16	16.31	16.77	17.22	17.67	18.13	18.58	19.03
1 7/8	16.88	17.34	17.81	18.28	18.75	19.22	19.69
1 15/16	17.44	17.92	18.41	18.89	19.38	19.86	20.34
2	*18.00*	*18.50*	19.00	19.50	20.00	20.50	21.00

AREAS OF FLAT ROLLED STEEL—Continued

Thickness in Inches	11"	11¼"	11½"	11¾"	12"	12¼"	12½"	12¾"
1/16	.688	.703	.719	.734	.750	.766	.781	.797
1/8	1.38	1.41	1.44	1.47	1.50	1.53	1.56	1.59
3/16	2.06	2.11	2.16	2.20	2.25	2.30	2.34	2.39
1/4	2.75	2.81	2.88	2.94	3.00	3.06	3.13	3.19
5/16	3.44	3.52	3.59	3.67	3.75	3.83	3.91	3.98
3/8	4.13	4.22	4.31	4.41	4.50	4.59	4.69	4.78
7/16	4.81	4.92	5.03	5.14	5.25	5.36	5.47	5.58
1/2	5.50	5.63	5.75	5.88	6.00	6.13	6.25	6.38
9/16	6.19	6.33	6.47	6.61	6.75	6.89	7.03	7.17
5/8	6.88	7.03	7.19	7.34	7.50	7.66	7.81	7.97
11/16	7.56	7.73	7.91	8.08	8.25	8.42	8.59	8.77
3/4	8.25	8.44	8.63	8.81	9.00	9.19	9.38	9.56
13/16	8.94	9.14	9.34	9.55	9.75	9.95	10.16	10.36
7/8	9.63	9.84	10.06	10.28	10.50	10.72	10.94	11.16
15/16	10.31	10.55	10.78	11.02	11.25	11.48	11.72	11.95
1	11.00	11.25	11.50	11.75	12.00	12.25	12.50	12.75
1 1/16	11.69	11.95	12.22	12.48	12.75	13.02	13.28	13.55
1 1/8	12.38	12.66	12.94	13.22	13.50	13.78	14.06	14.34
1 3/16	13.06	13.36	13.66	13.95	14.25	14.55	14.84	15.14
1 1/4	13.75	14.06	14.38	14.69	15.00	15.31	15.63	15.94
1 5/16	14.44	14.77	15.09	15.42	15.75	16.08	16.41	16.73
1 3/8	15.13	15.47	15.81	16.16	16.50	16.84	17.19	17.53
1 7/16	15.81	16.17	16.53	16.89	17.25	17.61	17.97	18.33
1 1/2	16.50	16.88	17.25	17.63	18.00	18.38	18.75	19.13
1 9/16	17.19	17.58	17.97	18.36	18.75	19.14	19.53	19.92
1 5/8	17.88	18.28	18.69	19.09	19.50	19.91	20.31	20.72
1 11/16	18.56	18.98	19.41	19.83	20.25	20.67	21.09	21.52
1 3/4	19.25	19.69	20.13	20.56	21.00	21.44	21.88	22.31
1 13/16	19.94	20.39	20.84	21.30	21.75	22.20	22.66	23.11
1 7/8	20.63	21.09	21.56	22.03	22.50	22.97	23.44	23.91
1 15/16	21.31	21.80	22.28	22.77	23.25	23.73	24.22	24.70
2	22.00	22.50	23.00	23.50	24.00	24.50	25.00	25.50

The areas for 12 in. width are repeated on each page to facilitate making the additions necessary to obtain the areas of plates wider than 12 in. Thus, to find the area of 15¼ x ⅞ in., add the areas to be found in the same line for 3¼ x ⅞ and 12 x ⅞ = 2.84 + 10.50 = 13.34 square inches.

WEIGHTS OF FLAT ROLLED STEEL

PER LINEAL FOOT

1 cubic foot weighing 489.6 lbs.

Thickness in Inches	1"	1¼"	1½"	1¾"	2"	2¼"	2½"	2¾"
3/16	.638	.797	.957	1.11	1.28	1.44	1.59	1.75
¼	.850	1.06	1.28	1.49	1.70	1.91	2.12	2.34
5/16	1.06	1.33	1.59	1.86	2.12	2.39	2.65	2.92
⅜	1.28	1.59	1.92	2.23	2.55	2.87	3.19	3.51
7/16	1.49	1.86	2.23	2.60	2.98	3.35	3.72	4.09
½	1.70	2.12	2.55	2.98	3.40	3.83	4.25	4.67
9/16	1.92	2.39	2.87	3.35	3.83	4.30	4.78	5.26
⅝	2.12	2.65	3.19	3.72	4.25	4.78	5.31	5.84
11/16	2.34	2.92	3.51	4.09	4.67	5.26	5.84	6.43
¾	2.55	3.19	3.83	4.47	5.10	5.75	6.38	7.02
13/16	2.76	3.45	4.14	4.84	5.53	6.21	6.90	7.60
⅞	2.98	3.72	4.47	5.20	5.95	6.69	7.44	8.18
15/16	3.19	3.99	4.78	5.58	6.38	7.18	7.97	8.77
1	3.40	4.25	5.10	5.95	6.80	7.65	8.50	9.35
1 1/16	3.61	4.52	5.42	6.32	7.22	8.13	9.03	9.93
1⅛	3.83	4.78	5.74	6.70	7.65	8.61	9.57	10.52
1 3/16	4.04	5.05	6.06	7.07	8.08	9.09	10.10	11.11
1¼	4.25	5.31	6.38	7.44	8.50	9.57	10.63	11.69
1 5/16	4.46	5.58	6.69	7.81	8.93	10.04	11.16	12.27
1⅜	4.67	5.84	7.02	8.18	9.35	10.52	11.69	12.85
1 7/16	4.89	6.11	7.34	8.56	9.78	11.00	12.22	13.44
1½	5.10	6.38	7.65	8.93	10.20	11.48	12.75	14.03
1 9/16	5.32	6.64	7.97	9.30	10.63	11.95	13.28	14.61
1⅝	5.52	6.90	8.29	9.67	11.05	12.43	13.81	15.19
1 11/16	5.74	7.17	8.61	10.04	11.47	12.91	14.34	15.78
1¾	5.95	7.44	8.93	10.42	11.90	13.40	14.88	16.37
1 13/16	6.16	7.70	9.24	10.79	12.33	13.86	15.40	16.95
1⅞	6.38	7.97	9.57	11.15	12.75	14.34	15.94	17.53
1 15/16	6.59	8.24	9.88	11.53	13.18	14.83	16.47	18.12
2	6.80	8.50	10.20	11.90	13.60	15.30	17.00	18.70

WEIGHTS OF FLAT ROLLED STEEL—Continued

PER LINEAL FOOT

in Inches	3″	3¼″	3½″	3¾″	4″	4¼″	4½″	4¾″	12″
3/16	1.91	2.07	2.23	2.39	2.55	2.71	2.87	3.03	7.65
1/4	2.55	2.76	2.98	3.19	3.40	3.61	3.83	4.04	10.20
5/16	3.19	3.45	3.72	3.99	4.25	4.52	4.78	5.05	12.75
3/8	3.83	4.15	4.47	4.78	5.10	5.42	5.74	6.06	15.30
7/16	4.46	4.83	5.20	5.58	5.95	6.32	6.70	7.07	17.85
1/2	5.10	5.53	5.95	6.38	6.80	7.22	7.65	8.08	20.40
9/16	5.74	6.22	6.70	7.17	7.65	8.13	8.61	9.09	22.95
5/8	6.38	6.91	7.44	7.97	8.50	9.03	9.57	10.10	25.50
11/16	7.02	7.60	8.18	8.76	9.35	9.93	10.52	11.11	28.05
3/4	7.65	8.29	8.93	9.57	10.20	10.84	11.48	12.12	30.60
13/16	8.29	8.98	9.67	10.36	11.05	11.74	12.43	13.12	33.15
7/8	8.93	9.67	10.41	11.16	11.90	12.65	13.39	14.13	35.70
15/16	9.57	10.36	11.16	11.95	12.75	13.55	14.34	15.14	38.25
	10.20	11.05	11.90	12.75	13.60	14.45	15.30	16.15	40.80
1/16	10.84	11.74	12.65	13.55	14.45	15.35	16.26	17.16	43.35
1/8	11.48	12.43	13.39	14.34	15.30	16.26	17.22	18.17	45.90
3/16	12.12	13.12	14.13	15.14	16.15	17.16	18.17	19.18	48.45
1/4	12.75	13.81	14.87	15.94	17.00	18.06	19.13	20.19	51.00
5/16	13.39	14.50	15.62	16.74	17.85	18.96	20.08	21.20	53.55
3/8	14.03	15.20	16.36	17.53	18.70	19.87	21.04	22.21	56.10
7/16	14.66	15.88	17.10	18.33	19.55	20.77	21.99	23.22	58.65
1/2	15.30	16.58	17.85	19.13	20.40	21.68	22.95	24.23	61.20
9/16	15.94	17.27	18.60	19.92	21.25	22.58	23.91	25.24	63.75
5/8	16.58	17.96	19.34	20.72	22.10	23.48	24.87	26.25	66.30
11/16	17.22	18.65	20.08	21.51	22.95	24.38	25.82	27.26	68.85
3/4	17.85	19.34	20.83	22.32	23.80	25.29	26.78	28.27	71.40
13/16	18.49	20.03	21.57	23.11	24.65	26.19	27.73	29.27	73.95
7/8	19.13	20.72	22.31	23.91	25.50	27.10	28.69	30.28	76.50
15/16	19.77	21.41	23.06	24.70	26.35	28.00	29.64	31.29	79.05
2	20.40	22.10	23.80	25.50	27.20	28.90	30.60	32.30	81.60

WEIGHTS OF FLAT ROLLED STEEL—C

PER LINEAL FOOT

Thickness in Inches	5"	5¼"	5½"	5¾"	6"	6¼"	6½"
$\frac{3}{16}$	3.19	3.35	3.51	3.67	3.83	3.99	4.14
¼	4.25	4.46	4.67	4.89	5.10	5.31	5.53
$\frac{5}{16}$	5.31	5.58	5.84	6.11	6.38	6.64	6.90
⅜	6.38	6.69	7.02	7.34	7.65	7.97	8.29
$\frac{7}{16}$	7.44	7.81	8.18	8.56	8.93	9.29	9.67
½	8.50	8.93	9.35	9.77	10.20	10.63	11.05
$\frac{9}{16}$	9.57	10.04	10.52	11.00	11.48	11.95	12.43
⅝	10.63	11.16	11.69	12.22	12.75	13.28	13.81
$\frac{11}{16}$	11.69	12.27	12.85	13.44	14.03	14.61	15.20
¾	12.75	13.39	14.03	14.67	15.30	15.94	16.58
$\frac{13}{16}$	13.81	14.50	15.19	15.88	16.58	17.27	17.95
⅞	14.87	15.62	16.36	17.10	17.85	18.60	19.34
$\frac{15}{16}$	15.94	16.74	17.53	18.33	19.13	19.92	20.72
1	17.00	17.85	18.70	19.55	20.40	21.25	22.10
$1\frac{1}{16}$	18.06	18.96	19.87	20.77	21.68	22.58	23.48
1⅛	19.13	20.08	21.04	21.99	22.95	23.91	24.87
$1\frac{3}{16}$	20.19	21.20	22.21	23.22	24.23	25.23	26.24
1¼	21.25	22.32	23.38	24.44	25.50	26.56	27.62
$1\frac{5}{16}$	22.32	23.43	24.54	25.66	26.78	27.90	29.01
1⅜	23.38	24.54	25.71	26.88	28.05	29.22	30.39
$1\frac{7}{16}$	24.44	25.66	26.88	28.10	29.33	30.55	31.77
1½	25.50	26.78	28.05	29.33	30.60	31.88	33.15
$1\frac{9}{16}$	26.57	27.89	29.22	30.55	31.88	33.20	34.53
1⅝	27.63	29.01	30.39	31.77	33.15	34.53	35.91
$1\frac{11}{16}$	28.69	30.12	31.55	32.99	34.43	35.86	37.30
1¾	29.75	31.24	32.73	34.22	35.70	37.19	38.68
$1\frac{13}{16}$	30.81	32.35	33.89	35.43	36.98	38.52	40.05
1⅞	31.87	33.47	35.06	36.65	38.25	39.85	41.44
$1\frac{15}{16}$	32.94	34.59	36.23	37.88	39.53	41.17	42.82
2	34.00	35.70	37.40	39.10	40.80	42.50	44.20

WEIGHTS OF FLAT ROLLED STEEL—Continued

PER LINEAL FOOT

Thickness in Inches	7"	7¼"	7½"	7¾"	8"	8¼"	8½"	8¾"	12"
3/16	4.46	4.62	4.78	4.94	5.10	5.26	5.42	5.58	7.65
¼	5.95	6.16	6.36	6.58	6.80	7.01	7.22	7.43	10.20
5/16	7.44	7.70	7.97	8.23	8.50	8.76	9.03	9.29	12.75
⅜	8.93	9.25	9.57	9.88	10.20	10.52	10.84	11.16	15.30
7/16	10.41	10.78	11.16	11.53	11.90	12.27	12.64	13.02	17.85
½	11.90	12.32	12.75	13.18	13.60	14.03	14.44	14.87	20.40
9/16	13.39	13.86	14.34	14.82	15.30	15.78	16.26	16.74	22.95
⅝	14.87	15.40	15.94	16.47	17.00	17.53	18.06	18.59	25.50
11/16	16.36	16.94	17.53	18.12	18.70	19.28	19.86	20.45	28.05
¾	17.85	18.49	19.13	19.77	20.40	21.04	21.68	22.32	30.60
13/16	19.34	20.03	20.72	21.41	22.10	22.79	23.48	24.17	33.15
⅞	20.83	21.57	22.32	23.05	23.80	24.55	25.30	26.04	35.70
15/16	22.32	23.11	23.91	24.70	25.50	26.30	27.10	27.89	38.25
	23.80	24.65	25.50	26.35	27.20	28.05	28.90	29.75	40.80
1/16	25.29	26.19	27.10	28.00	28.90	29.80	30.70	31.61	43.35
⅛	26.78	27.73	28.68	29.64	30.60	31.56	32.52	33.47	45.90
3/16	28.26	29.27	30.28	31.29	32.30	33.31	34.32	35.33	48.45
¼	29.75	30.81	31.88	32.94	34.00	35.06	36.12	37.20	51.00
5/16	31.23	32.35	33.48	34.59	35.70	36.81	37.93	39.05	53.55
⅜	32.72	33.89	35.06	36.23	37.40	38.57	39.74	40.91	56.10
7/16	34.21	35.44	36.66	37.88	39.10	40.32	41.54	42.77	58.65
½	35.70	36.98	38.26	39.53	40.80	42.08	43.35	44.63	61.20
9/16	37.19	38.51	39.84	41.17	42.50	43.83	45.16	46.49	63.75
⅝	38.67	40.05	41.44	42.82	44.20	45.58	46.96	48.34	66.30
11/16	40.16	41.59	43.03	44.47	45.90	47.33	48.76	50.20	68.85
¾	41.65	43.14	44.63	46.12	47.60	49.09	50.58	52.07	71.40
13/16	43.14	44.68	46.22	47.76	49.30	50.84	52.38	53.92	73.95
⅞	44.63	46.22	47.82	49.40	51.00	52.60	54.20	55.79	76.50
15/16	46.12	47.76	49.41	51.05	52.70	54.35	56.00	57.64	79.05
	47.60	49.30	51.00	52.70	54.40	56.10	57.80	59.50	81.6

WEIGHTS OF FLAT ROLLED STEEL—Con

PER LINEAL FOOT

Thickness in Inches	9"	9¼"	9½"	9¾"	10"	10¼"	10½"	10
$\frac{3}{16}$	5.74	5.90	6.06	6.22	6.38	6.54	6.70	6.
¼	7.65	7.86	8.08	8.29	8.50	8.71	8.92	9.
$\frac{5}{16}$	9.56	9.83	10.10	10.36	10.62	10.89	11.16	11.
⅜	11.48	11.80	12.12	12.44	12.75	13.07	13.39	13.
$\frac{7}{16}$	13.40	13.76	14.14	14.51	14.88	15.25	15.62	15.
½	15.30	15.73	16.16	16.58	17.00	17.42	17.85	18.
$\frac{9}{16}$	17.22	17.69	18.18	18.65	19.14	19.61	20.08	20.
⅝	19.13	19.65	20.19	20.72	21.25	21.78	22.32	22.
$\frac{11}{16}$	21.04	21.62	22.21	22.79	23.38	23.96	24.54	25.
¾	22.96	23.59	24.23	24.86	25.50	26.14	26.78	27.
$\frac{13}{16}$	24.86	25.55	26.24	26.94	27.62	28.32	29.00	29.
⅞	26.78	27.52	28.26	29.01	29.75	30.50	31.24	31.
$\frac{15}{16}$	28.69	29.49	30.28	31.08	31.88	32.67	33.48	34.
1	30.60	31.45	32.30	33.15	34.00	34.85	35.70	36.
$1\frac{1}{16}$	32.52	33.41	34.32	35.22	36.12	37.03	37.92	38.
1⅛	34.43	35.38	36.34	37.29	38.25	39.21	40.17	41.
$1\frac{3}{16}$	36.34	37.35	38.36	39.37	40.38	41.39	42.40	43.
1¼	38.26	39.31	40.37	41.44	42.50	43.56	44.63	45.
$1\frac{5}{16}$	40.16	41.28	42.40	43.52	44.64	45.75	46.86	47.
1⅜	42.08	43.25	44.41	45.58	46.75	47.92	49.08	50.
$1\frac{7}{16}$	44.00	45.22	46.44	47.66	48.88	50.10	51.32	52.
1½	45.90	47.18	48.45	49.73	51.00	52.28	53.55	54.
$1\frac{9}{16}$	47.82	49.14	50.48	51.80	53.14	54.46	55.78	57.
1⅝	49.73	51.10	52.49	53.87	55.25	56.63	58.02	59.
$1\frac{11}{16}$	51.64	53.07	54.51	55.94	57.38	58.81	60.24	61.
1¾	53.56	55.04	56.53	58.01	59.50	60.99	62.48	63.
$1\frac{13}{16}$	55.46	57.00	58.54	60.09	61.62	63.17	64.70	66.
1⅞	57.38	58.97	60.56	62.16	63.75	65.35	66.94	68.
$1\frac{15}{16}$	59.29	60.94	62.58	64.23	65.88	67.52	69.18	70.
2	61.20	62.90	64.60	66.30	68.00	69.70	71.40	73.

WEIGHTS OF FLAT ROLLED STEEL—Continued

PER LINEAL FOOT

Thickness in Inches	11″	11¼″	11½″	11¾″	12″	12¼″	12½″	12¾″
3/16	7.02	7.17	7.32	7.49	7.65	7.82	7.98	8.13
¼	9.34	9.57	9.78	10.00	10.20	10.42	10.63	10.84
5/16	11.68	11.95	12.22	12.49	12.75	13.01	13.28	13.55
⅜	14.03	14.35	14.68	14.99	15.30	15.62	15.94	16.26
7/16	16.36	16.74	17.12	17.49	17.85	18.23	18.60	18.97
½	18.70	19.13	19.55	19.97	20.40	20.82	21.25	21.67
9/16	21.02	21.51	22.00	22.48	22.95	23.43	23.90	24.39
⅝	23.38	23.91	24.44	24.97	25.50	26.03	26.56	27.09
11/16	25.70	26.30	26.88	27.47	28.05	28.64	29.22	29.80
¾	28.05	28.68	29.33	29.97	30.60	31.25	31.88	32.52
13/16	30.40	31.08	31.76	32.46	33.15	33.83	34.53	35.22
⅞	32.72	33.47	34.21	34.95	35.70	36.44	37.19	37.93
15/16	35.06	35.86	36.66	37.46	38.25	39.05	39.84	40.64
1	37.40	38.25	39.10	39.95	40.80	41.65	42.50	43.35
1 1/16	39.74	40.64	41.54	42.45	43.35	44.25	45.16	46.06
1⅛	42.08	43.04	44.00	44.94	45.90	46.86	47.82	48.77
1 3/16	44.42	45.42	46.44	47.45	48.45	49.46	50.46	51.48
1¼	46.76	47.82	48.88	49.94	51.00	52.06	53.12	54.19
1 5/16	49.08	50.20	51.32	52.44	53.55	54.67	55.78	56.90
1⅜	51.42	52.59	53.76	54.93	56.10	57.27	58.44	59 60
1 7/16	53.76	54.99	56.21	57.43	58.65	59.87	61.10	62.32
1½	56.10	57.37	58.65	59.93	61.20	62.48	63.75	65.03
1 9/16	58.42	59.76	61.10	62.43	63.75	65.08	66.40	67.74
1⅝	60.78	62.16	63.54	64.92	66.30	67.68	69.06	70.44
1 11/16	63.10	64.55	65.98	67.42	68.85	70.29	71.72	73.15
1¾	65.45	66.93	68.43	69.92	71.40	72.90	74.38	75.87
1 13/16	67.80	69.33	70.86	72.41	73.95	75.48	77.03	78.57
1⅞	70.12	71.72	73.31	74.90	76.50	78.09	79.69	81.28
1 15/16	72.46	74.11	75.76	77.41	79.05	80.70	82.34	83.99
2	74.80	76.50	78.20	79.90	81.60	83.30	85.00	86.70

The weights for 12 in. width are repeated on each page to facilitate making the additions necessary to obtain the weights of plates wider than 12 in. Thus, to find the weight of 15½ × ⅞ in., add the weights to be found in the same line for 3½ × ⅞ and 12 × ⅞ = 10.41 + 35.70 = 46.11 lbs.

WEIGHTS OF FLAT ROLLED STEEL—

PER LINEAL FOOT

Thickness in Inches	13″	14″	15″	16″	17″	18″	19″
$\frac{3}{16}$	8.28	8.92	9.56	10.20	10.84	11.48	12.10
$\frac{1}{4}$	11.06	11.90	12.75	13.60	14.44	15.30	16.16
$\frac{5}{16}$	13.81	14.88	15.94	17.00	18.06	19.12	20.20
$\frac{3}{8}$	16.58	17.86	19.14	20.40	21.68	22.96	24.24
$\frac{7}{16}$	19.34	20.82	22.32	23.80	25.28	26.79	28.28
$\frac{1}{2}$	22.10	23.80	25.50	27.20	28.89	30.60	32.31
$\frac{9}{16}$	24.86	26.78	28.70	30.60	32.52	34.44	36.34
$\frac{5}{8}$	27.62	29.74	31.88	34.00	36.12	38.25	40.37
$\frac{11}{16}$	30.39	32.72	35.06	37.40	39.72	42.08	44.42
$\frac{3}{4}$	33.16	35.71	38.26	40.80	43.36	45.92	48.46
$\frac{13}{16}$	35.91	38.67	41.43	44.20	46.96	49.72	52.48
$\frac{7}{8}$	38.68	41.65	44.62	47.60	50.60	53.56	56.52
$\frac{15}{16}$	41.44	44.63	47.82	51.00	54.20	57.38	60.57
1	44.20	47.60	51.00	54.40	57.80	61.20	64.60
$1\frac{1}{16}$	46.96	50.57	54.20	57.80	61.40	65.02	68.64
$1\frac{1}{8}$	49.72	53.55	57.37	61.20	65.04	68.85	72.68
$1\frac{3}{16}$	52.48	56.52	60.56	64.60	68.64	72.68	76.72
$1\frac{1}{4}$	55.25	59.50	63.76	68.00	72.26	76.50	80.74
$1\frac{5}{16}$	58.02	62.47	66.95	71.40	75.86	80.33	84.80
$1\frac{3}{8}$	60.77	65.45	70.12	74.80	79.48	84.15	88.83
$1\frac{7}{16}$	63.54	68.42	73.32	78.20	83.08	88.00	92.88
$1\frac{1}{2}$	66.30	71.40	76.51	81.60	86.70	91.80	96.90
$1\frac{9}{16}$	69.06	74.38	79.69	85.00	90.31	95.63	100.94
$1\frac{5}{8}$	71.83	77.35	82.88	88.40	93.93	99.45	104.98
$1\frac{11}{16}$	74.59	80.33	86.06	91.80	97.54	103.28	109.01
$1\frac{3}{4}$	77.35	83.30	89.25	95.20	101.15	107.10	113.05
$1\frac{13}{16}$	80.11	86.28	92.44	98.60	104.76	110.93	117.09
$1\frac{7}{8}$	82.88	89.25	95.63	102.00	108.38	114.75	121.13
$1\frac{15}{16}$	85.64	92.23	98.81	105.40	111.99	118.58	125.16
2	*88.40*	*95.20*	102.00	108.80	115.60	122.40	129.20

WEIGHTS OF FLAT ROLLED STEEL—Continued

PER LINEAL FOOT

in Inches	22″	23″	24″	25″	26″	27″	28″	29″	30″
3/16	14.04	14.64	15.32	15.96	16.56	17.20	17.84	18.48	19.12
1/4	18.69	19.56	20.40	21.26	22.12	22.96	23.80	24.64	25.50
5/16	23.36	24.44	25.52	26.56	27.62	28.68	29.76	30.80	31.88
3/8	28.06	29.33	30.60	31.88	33.16	34.44	35.72	37.00	38.28
7/16	32.72	34.24	35.72	37.20	38.68	40.17	41.65	43.14	44.64
1/2	37.40	39.10	40.80	42.50	44.20	45.92	47.60	49.28	51.00
9/16	42.04	44.00	45.92	47.80	49.73	51.64	53.56	55.48	57.40
5/8	46.76	48.88	51.00	53.12	55.24	57.37	59.49	61.60	63.76
11/16	51.40	53.76	56.12	58.44	60.78	63.11	65.44	67.77	70.13
3/4	56.10	58.66	61.20	63.76	66.32	68.88	71.42	73.97	76.53
13/16	60.79	63.53	66.29	69.06	71.82	74.58	77.34	80.10	82.86
7/8	65.44	68.43	71.40	74.38	77.36	80.33	83.30	86.29	89.24
15/16	70.13	73.32	76.50	79.68	82.88	86.07	89.26	92.44	95.64
1	74.80	78.20	81.60	85.00	88.40	91.80	95.20	98.60	102.00
1 1/16	79.48	83.08	86.70	90.32	93.92	97.54	101.14	104.75	108.38
1 1/8	84.16	88.00	91.80	95.64	99.44	103.26	107.10	110.92	114.74
1 3/16	88.83	92.88	96.92	100.92	104.96	109.01	113.05	117.09	121.13
1 1/4	93.52	97.76	102.00	106.24	110.50	114.76	119.00	123.24	127.51
1 5/16	98.16	102.64	107.12	111.56	116.04	120.50	124.94	129.40	133.89
1 3/8	102.84	107.52	112.20	116.88	121.54	126.22	130.90	135.58	140.24
1 7/16	107.52	112.42	117.30	122.20	127.08	131.96	136.84	141.76	146.64
1 1/2	112.20	117.30	122.40	127.50	132.60	137.72	142.80	147.92	153.02
1 9/16	116.88	122.19	127.50	132.81	138.13	143.44	148.75	154.06	159.38
1 5/8	121.55	127.08	132.60	138.13	143.65	149.18	154.70	160.23	165.75
1 11/16	126.23	131.96	137.70	143.44	149.18	154.91	160.65	166.39	172.13
1 3/4	130.90	136.85	142.80	148.75	154.70	160.65	166.60	172.55	187.50
1 13/16	135.58	141.74	147.90	154.06	160.23	166.39	172.55	178.71	184.88
1 7/8	140.25	146.63	153.00	159.38	165.75	172.13	178.50	184.88	191.25
1 15/16	144.93	151.51	158.10	164.69	171.28	177.86	184.45	191.04	197.63
2	149.60	156.40	163.20	170.00	176.80	183.60	190.40	197.20	204.00

WEIGHTS OF FLAT ROLLED STEEL—Cont

PER LINEAL FOOT

Thickness in Inches	31″	32″	33″	34″	35″	36″	38″	40″
3/16	19.75	20.40	21.04	21.68	22.32	22.96	24.20	25.5
1/4	26.36	27.20	28.04	28.88	29.72	30.59	32.32	34.0
5/16	32.94	34.00	35.04	36.12	37.16	38.24	40.39	42.4
3/8	39.54	40.80	42.08	43.36	44.64	45.92	48.48	51.0
7/16	46.12	47.60	49.08	50.57	52.07	53.58	56.56	59.5
1/2	52.70	54.40	56.10	57.78	59.50	61.20	64.62	68.0
9/16	59.32	61.22	63.12	65.04	66.96	68.88	72.68	76.5
5/8	65.88	68.00	70.13	72.24	74.36	76.50	80.74	85.0
11/16	72.48	74.80	77.12	79.44	81.79	84.15	88.84	93.4
3/4	79.08	81.61	84.16	86.72	89.28	91.84	96.92	102.0
13/16	85.62	88.39	91.15	93.91	96.68	99.44	104.96	110.5
7/8	92.20	95.20	98.20	101.20	104.16	107.12	113.04	119.0
15/16	98.82	102.00	105.20	108.40	111.59	114.76	121.14	127.5
1	105.40	108.80	112.20	115.60	119.00	122.40	129.20	136.0
1 1/16	112.00	115.59	119.20	122.80	126.42	130.04	137.28	144.5
1 1/8	118.56	122.40	126.24	130.08	133.90	137.70	145.36	153.0
1 3/16	125.16	129.21	133.24	137.28	141.32	145.36	153.44	161.5
1 1/4	131.76	136.00	140.28	144.52	148.76	153.00	161.48	170.0
1 5/16	138.36	142.81	147.24	151.72	156.20	160.66	169.60	178.5
1 3/8	144.92	149.60	154.28	158.96	163.62	168.30	177.66	187.0
1 7/16	151.52	156.40	161.28	166.16	171.08	176.00	185.75	195.5
1 1/2	158.11	163.20	168.32	173.40	178.51	183.60	193.80	204.0
1 9/16	164.69	170.00	175.31	180.63	185.94	191.25	201.88	212.5
1 5/8	171.28	176.80	182.33	187.85	193.38	198.90	209.95	221.0
1 11/16	177.86	183.60	189.34	195.08	200.81	206.55	218.03	229.5
1 3/4	184.45	190.40	196.35	202.30	208.25	214.20	226.10	238.0
1 13/16	191.04	197.20	203.36	209.53	215.69	221.85	234.18	246.5
1 7/8	197.63	204.00	210.38	216.75	223.13	229.50	242.25	255.0
1 15/16	204.21	210.80	217.39	223.98	230.56	237.15	250.33	263.5
2	210.80	217.60	224.40	231.20	238.00	244.80	258.40	272.0

WEIGHTS OF FLAT ROLLED STEEL—Continued

PER LINEAL FOOT

Thickness in Inches	44″	46″	48″	50″	52″	54″	56″	58″	60″
$\frac{3}{16}$	28.08	29.29	30.64	31.92	33.12	34.40	35.68	36.96	38.24
$\frac{1}{4}$	37.38	39.11	40.80	42.52	44.24	45.92	47.60	49.28	51.0
$\frac{5}{16}$	46.72	48.88	51.04	53.12	55.24	57.36	59.51	61.60	63.7
$\frac{3}{8}$	56.12	58.65	61.20	63.76	66.32	68.88	71.44	74.00	76.5
$\frac{7}{16}$	65.44	68.47	71.44	74.40	77.37	80.34	83.30	86.28	89.2
$\frac{1}{2}$	74.80	78.20	81.60	85.00	88.40	91.84	95.20	98.56	102.0
$\frac{9}{16}$	84.09	88.00	91.84	95.60	99.46	103.28	107.12	110.96	114.8
$\frac{5}{8}$	93.52	97.76	102.00	106.24	110.48	114.74	118.98	123.20	127.5
$\frac{11}{16}$	102.81	107.53	112.24	116.88	121.56	126.22	130.88	135.54	140.2
$\frac{3}{4}$	112.20	117.31	122.40	127.52	132.64	137.76	142.85	147.94	153.0
$\frac{13}{16}$	121.56	127.06	132.58	138.12	143.64	149.16	154.68	160.20	165.7
$\frac{7}{8}$	130.89	136.86	142.80	148.76	154.72	160.66	166.60	172.58	178.4
$\frac{15}{16}$	140.27	146.64	153.00	159.36	165.76	172.15	178.52	184.88	191.2
1	149.60	156.40	163.20	170.00	176.80	183.60	190.40	197.20	204.0
$1\frac{1}{16}$	158.96	166.16	173.40	180.64	187.84	195.08	202.28	209.50	216.7
$1\frac{1}{8}$	168.32	175.99	183.60	191.28	198.88	206.52	214.20	221.84	229.4
$1\frac{3}{16}$	177.66	185.76	193.84	201.84	209.92	218.02	226.10	234.18	242.2
$1\frac{1}{4}$	187.04	195.52	204.00	212.48	221.00	229.52	238.00	246.48	255.0
$1\frac{5}{16}$	196.32	205.28	214.24	223.12	232.08	241.00	249.88	258.80	267.7
$1\frac{3}{8}$	205.68	215.04	224.40	233.76	243.08	252.44	261.80	271.16	280.4
$1\frac{7}{16}$	215.04	224.84	234.60	244.40	254.16	263.92	273.68	283.52	293.2
$1\frac{1}{2}$	224.40	234.60	244.80	255.00	265.20	275.44	285.60	295.84	306.0
$1\frac{9}{16}$	233.75	244.38	255.00	265.63	276.25	286.88	297.50	308.13	318.7
$1\frac{5}{8}$	243.10	254.15	265.20	276.25	287.30	298.35	309.40	320.45	331.5
$1\frac{11}{16}$	252.45	263.93	275.40	286.88	298.35	309.83	321.30	332.78	344.2
$1\frac{3}{4}$	261.80	273.70	285.60	297.50	309.40	321.30	333.20	345.10	357.0
$1\frac{13}{16}$	271.15	283.48	295.80	308.13	320.45	332.78	345.10	357.43	369.7
$1\frac{7}{8}$	280.50	293.25	306.00	318.75	331.50	344.25	357.00	369.75	382.5
$1\frac{15}{16}$	289.85	303.03	316.20	329.38	342.55	355.73	368.90	382.08	395.2
2	299.20	312.80	326.40	340.00	353.60	367.20	380.80	394.40	408.

WEIGHTS AND AREAS OF SQUARE AND ROUND BARS AND CIRCUMFERENCES OF ROUND BARS

One cubic foot of steel weighing 489.6 lbs.

Thickness or Diameter in Inches	Weight of □ Bar One Foot Long	Weight of ○ Bar One Foot Long	Area of □ Bar in Sq. Inches	Area of ○ Bar in Sq. Inches	Circumference of ○ Bar in Inches
0					
1/16	.013	.010	.0039	.0031	.1963
1/8	.053	.042	.0156	.0123	.3927
3/16	.119	.094	.0352	.0276	.5890
1/4	.212	.167	.0625	.0491	.7854
5/16	.333	.261	.0977	.0767	.9817
3/8	.478	.375	.1406	.1104	1.1781
7/16	.651	.511	.1914	.1503	1.3744
1/2	.850	.667	.2500	.1963	1.5708
9/16	1.076	.845	.3164	.2485	1.7671
5/8	1.328	1.043	.3906	.3068	1.9635
11/16	1.608	1.262	.4727	.3712	2.1598
3/4	1.913	1.502	.5625	.4418	2.3562
13/16	2.245	1.763	.6602	.5185	2.5525
7/8	2.603	2.044	.7656	.6013	2.7489
15/16	2.989	2.347	.8789	.6903	2.9452
1	3.400	2.670	1.0000	.7854	3.1416
1/16	3.838	3.014	1.1289	.8866	3.3379
1/8	4.303	3.379	1.2656	.9940	3.5343
3/16	4.795	3.766	1.4102	1.1075	3.7306
1/4	5.312	4.173	1.5625	1.2272	3.9270
5/16	5.857	4.600	1.7227	1.3530	4.1233
3/8	6.428	5.049	1.8906	1.4849	4.3197
7/16	7.026	5.518	2.0664	1.6230	4.5160
1/2	7.650	6.008	2.2500	1.7671	4.7124
9/16	8.301	6.520	2.4414	1.9175	4.9087
5/8	8.978	7.051	2.6406	2.0739	5.1051
11/16	9.682	7.604	2.8477	2.2365	5.3014
3/4	10.41	8.178	3.0625	2.4053	5.4978
13/16	11.17	8.773	3.2852	2.5802	5.6941
7/8	11.95	9.388	3.5156	2.7612	5.8905
15/16	12.76	10.02	3.7539	2.9483	6.0868

SQUARE AND ROUND BARS—Continued

Thickness or Diameter in Inches	Weight of □ Bar One Foot Long	Weight of ○ Bar One Foot Long	Area of □ Bar in Sq. Inches	Area of ○ Bar in Sq. Inches	Circumference of ○ Bar in Inches
2	13.60	10.68	4.0000	3.1416	6.2832
1/16	14.46	11.36	4.2539	3.3410	6.4795
1/8	15.35	12.06	4.5156	3.5466	6.6759
3/16	16.27	12.78	4.7852	3.7583	6.8722
1/4	17.22	13.52	5.0625	3.9761	7.0686
5/16	18.19	14.28	5.3477	4.2000	7.2649
3/8	19.18	15.07	5.6406	4.4301	7.4613
7/16	20.20	15.86	5.9414	4.6664	7.6576
1/2	21.25	16.69	6.2500	4.9087	7.8540
9/16	22.33	17.53	6.5664	5.1572	8.0503
5/8	23.43	18.40	6.8906	5.4119	8.2467
11/16	24.56	19.29	7.2227	5.6727	8.4430
3/4	25.71	20.20	7.5625	5.9396	8.6394
13/16	26.90	21.12	7.9102	6.2126	8.8357
7/8	28.10	22.07	8.2656	6.4918	9.0321
15/16	29.34	23.04	8.6289	6.7771	9.2284
3	30.60	24.03	9.0000	7.0686	9.4248
1/16	31.89	25.04	9.3789	7.3662	9.6211
1/8	33.20	26.08	9.7656	7.6699	9.8175
3/16	34.55	27.13	10.160	7.9798	10.014
1/4	35.92	28.20	10.563	8.2958	10.210
5/16	37.31	29.30	10.973	8.6179	10.407
3/8	38.73	30.42	11.391	8.9462	10.603
7/16	40.18	31.56	11.816	9.2806	10.799
1/2	41.65	32.71	12.250	9.6211	10.996
9/16	43.14	33.90	12.691	9.9678	11.192
5/8	44.68	35.09	13.141	10.321	11.388
11/16	46.24	36.31	13.598	10.680	11.585
3/4	47.82	37.56	14.063	11.045	11.781
13/16	49.42	38.81	14.535	11.416	11.977
7/8	51.05	40.10	15.016	11.793	12.174
15/16	52.71	41.40	15.504	12.177	12.370

SQUARE AND ROUND BARS—Continue

Thickness or Diameter in Inches	Weight of □ Bar One Foot Long	Weight of ○ Bar One Foot Long	Area of □ Bar in Sq. Inches	Area of ○ Bar in Sq. Inches	Cir of i
4	54.40	42.73	16.000	12.566	1
1/16	56.11	44.07	16.504	12.962	1
1/8	57.85	45.44	17.016	13.364	1
3/16	59.62	46.83	17.535	13.772	1
1/4	61.41	48.24	18.063	14.186	1
5/16	63.23	49.66	18.598	14.607	1
3/8	65.08	51.11	19.141	15.033	1
7/16	66.95	52.58	19.691	15.466	1
1/2	68.85	54.07	20.250	15.904	1
9/16	70.78	55.59	20.816	16.349	1
5/8	72.73	57.12	21.391	16.800	1
11/16	74.70	58.67	21.973	17.257	1
3/4	76.71	60.25	22.563	17.721	1
13/16	78.74	61.84	23.160	18.190	1
7/8	80.81	63.46	23.766	18.665	1
15/16	82.89	65.10	24.379	19.147	1
5	85.00	66.76	25.000	19.635	1
1/16	87.14	68.44	25.629	20.129	1
1/8	89.30	70.14	26.266	20.629	1
3/16	91.49	71.86	26.910	21.135	1
1/4	93.72	73.60	27.563	21.648	1
5/16	95.96	75.37	28.223	22.166	1
3/8	98.23	77.15	28.891	22.691	1
7/16	100.5	78.95	29.566	23.221	1
1/2	102.8	80.77	30.250	23.758	1
9/16	105.2	82.62	30.941	24.301	1
5/8	107.6	84.49	31.641	24.850	1
11/16	110.0	86.38	32.348	25.406	1
3/4	112.4	88.29	33.063	25.967	1
13/16	114.9	90.22	33.785	26.535	1
7/8	117.4	92.17	34.516	27.109	1
15/16	119.9	94.14	35.254	27.688	1

SQUARE AND ROUND BARS—Continued

Weight of □ Bar One Foot Long	Weight of ○ Bar One Foot Long	Area of □ Bar in Sq. Inches	Area of ○ Bar in Sq. Inches	Circumference of ○ Bar in Inches
122.4	96.14	36.000	28.274	18.850
125.0	98.14	36.754	28.866	19.046
127.6	100.2	37.516	29.465	19.242
130.2	102.2	38.285	30.069	19.439
132.8	104.3	39.063	30.680	19.635
135.5	106.4	39.848	31.296	19.831
138.2	108.5	40.641	31.919	20.028
140.9	110.7	41.441	32.548	20.224
143.6	112.8	42.250	33.183	20.420
146.5	114.9	43.066	33.824	20.617
149.2	117.2	43.891	34.472	20.813
152.1	119.4	44.723	35.125	21.009
154.9	121.7	45.563	35.785	21.206
157.8	123.9	46.410	36.450	21.402
160.8	126.2	47.266	37.122	21.598
163.6	128.5	48.129	37.800	21.795
166.6	130.9	49.000	38.485	21.991
169.6	133.2	49.879	39.175	22.187
172.6	135.6	50.766	39.871	22.384
175.6	137.9	51.660	40.574	22.580
178.7	140.4	52.563	41.282	22.777
181.8	142.8	53.473	41.997	22.973
184.9	145.3	54.391	42.718	23.169
188.1	147.7	55.316	43.445	23.366
191.3	150.2	56.250	44.179	23.562
194.4	152.7	57.191	44.918	23.758
197.7	155.2	58.141	45.664	23.955
200.9	157.8	59.098	46.415	24.151
204.2	160.3	60.063	47.173	24.347
207.6	163.0	61.035	47.937	24.544
210.8	165.6	62.016	48.707	24.740
214.2	168.2	63.004	49.483	24.936

SQUARE AND ROUND BARS—Continued

Thickness or Diameter in Inches	Weight of □ Bar One Foot Long	Weight of ○ Bar One Foot Long	Area of □ Bar in Sq. Inches	Area of ○ Bar in Sq. Inches	Circumference of ○ Bar in Inches
8	217.6	171.0	64.000	50.265	25.133
1/16	221.0	173.6	65.004	51.054	25.329
1/8	224.5	176.3	66.016	51.849	25.525
3/16	228.0	179.0	67.035	52.649	25.722
1/4	231.4	181.8	68.063	53.456	25.918
5/16	234.9	184.5	69.098	54.269	26.114
3/8	238.5	187.3	70.141	55.088	26.311
7/16	242.0	190.1	71.191	55.914	26.507
1/2	245.6	193.0	72.250	56.745	26.704
9/16	249.3	195.7	73.316	57.583	26.900
5/8	252.9	198.7	74.391	58.426	27.096
11/16	256.6	201.6	75.473	59.276	27.293
3/4	260.3	204.4	76.563	60.132	27.489
13/16	264.1	207.4	77.660	60.994	27.685
7/8	267.9	210.3	78.766	61.862	27.882
15/16	271.6	213.3	79.879	62.737	28.078
9	275.4	216.3	81.000	63.617	28.274
1/16	279.3	219.3	82.129	64.505	28.471
1/8	283.2	222.4	83.266	65.397	28.667
3/16	287.0	225.4	84.410	66.296	28.863
1/4	290.9	228.5	85.563	67.201	29.060
5/16	294.9	231.5	86.723	68.112	29.256
3/8	298.9	234.7	87.891	69.029	29.452
7/16	302.8	237.9	89.066	69.953	29.649
1/2	306.8	241.0	90.250	70.882	29.845
9/16	310.9	244.2	91.441	71.818	30.041
5/8	315.0	247.4	92.641	72.760	30.238
11/16	319.1	250.6	93.848	73.708	30.434
3/4	323.2	253.9	95.063	74.662	30.631
13/16	327.4	257.1	96.285	75.622	30.827
7/8	331.6	260.4	97.516	76.589	31.023
15/16	335.8	263.7	98.754	77.561	31.022

SQUARE AND ROUND BARS—Continued

Weight of □ Bar One Foot Long	Weight of ○ Bar One Foot Long	Area of □ Bar in Sq. Inches	Area of ○ Bar in Sq. Inches	Circumference of ○ Bar in Inches
340.0	267.0	100.00	78.540	31.416
344.3	270.4	101.25	79.525	31.612
348.5	273.8	102.52	80.516	31.809
352.9	277.1	103.79	81.513	32.005
357.2	280.6	105.06	82.516	32.201
361.6	284.0	106.35	83.525	32.398
366.0	287.4	107.64	84.541	32.594
370.4	290.9	108.94	85.562	32.790
374.9	294.4	110.25	86.590	32.987
379.4	297.9	111.57	87.624	33.183
383.8	301.4	112.89	88.664	33.379
388.3	305.0	114.22	89.710	33.576
392.9	308.6	115.56	90.763	33.772
397.5	312.2	116.91	91.821	33.968
402.1	315.8	118.27	92.886	34.165
406.8	319.5	119.63	93.956	34.361
411.4	323.1	121.00	95.033	34.558
416.1	326.8	122.38	96.116	34.754
420.9	330.5	123.77	97.205	34.950
425.5	334.3	125.16	98.301	35.147
430.3	337.9	126.56	99.402	35.343
435.1	341.7	127.97	100.51	35.539
439.9	345.5	129.39	101.62	35.736
444.8	349.4	130.82	102.74	35.932
449.6	353.1	132.25	103.87	36.128
454.5	357.0	133.69	105.00	36.325
459.5	360.9	135.14	106.14	36.521
464.4	364.8	136.60	107.28	36.717
469.4	368.6	138.06	108.43	36.914
474.4	372.6	139.54	109.59	37.110
479.5	376.6	141.02	110.75	37.306
484.5	380.6	142.50	111.92	37.503

WEIGHT OF SHEETS OF WROUGHT IRON, S
COPPER AND BRASS (FROM HASWELL)

Weights per square foot. Thickness by Birmingham Gau

No. of Gauge	Thickness in Inches	Iron	Steel	Copper	
0000	.454	18.22	18.46	20.57	1
000	.425	17.05	17.28	19.25	1
00	.38	15.25	15.45	17.21	1
0	.34	13.64	13.82	15.40	1
1	.3	12.04	12.20	13.59	1
2	.284	11.40	11.55	12.87	1
3	.259	10.39	10.53	11.73	1
4	.238	9.55	9.68	10.78	1
5	.22	8.83	8.95	9.97	
6	.203	8.15	8.25	9.20	
7	.18	7.22	7.32	8.15	
8	.165	6.62	6.71	7.47	
9	.148	5.94	6.02	6.70	
10	.134	5.38	5.45	6.07	
11	.12	4.82	4.88	5.44	
12	.109	4.37	4.43	4.94	
13	.095	3.81	3.86	4.30	
14	.083	3.33	3.37	3.76	
15	.072	2.89	2.93	3.26	
16	.065	2.61	2.64	2.94	
17	.058	2.33	2.36	2.63	
18	.049	1.97	1.99	2.22	
19	.042	1.69	1.71	1.90	
20	.035	1.40	1.42	1.59	
21	.032	1.28	1.30	1.45	
22	.028	1.12	1.14	1.27	
23	.025	1.00	1.02	1.13	
24	.022	.883	.895	1.00	
25	.02	.803	.813	.906	
26	.018	.722	.732	.815	
27	.016	.642	.651	.725	
28	.014	.562	.569	.634	
29	.013	.522	.529	.589	
30	.012	.482	.488	.544	
31	.01	.401	.407	.453	
32	.009	.361	.366	.408	
33	.008	.321	.325	.362	
34	.007	.281	.285	.317	
35	.005	.201	.203	.227	
Specific gravity		7.704	7.806	8.698	
Weight cubic foot		481.75	487.75	543.6	51
Weight cubic inch		.2787	.2823	.3146	

VEIGHT OF SHEETS OF WROUGHT IRON, STEEL, COPPER AND BRASS (FROM HASWELL)

Veights per sq. ft. Thickness by American (Browne & Sharpe's) Gauge

No. of Gauge	Thickness in Inches	Iron	Steel	Copper	Brass
0000	.46	18.46	18.70	20.84	19.69
000	.4096	16.44	16.66	18.56	17.53
00	.3648	14.64	14.83	16.53	15.61
0	.3249	13.04	13.21	14.72	13.90
1	.2893	11.61	11.76	13.11	12.38
2	.2576	10.34	10.48	11.67	11.03
3	.2294	9.21	9.33	10.39	9.82
4	.2043	8.20	8.31	9.26	8.74
5	.1819	7.30	7.40	8.24	7.79
6	.1620	6.50	6.59	7.34	6.93
7	.1443	5.79	5.87	6.54	6.18
8	.1285	5.16	5.22	5.82	5.50
9	.1144	4.59	4.65	5.18	4.90
10	.1019	4.09	4.14	4.62	4.36
11	.0907	3.64	3.69	4.11	3.88
12	.0808	3.24	3.29	3.66	3.46
13	.0720	2.89	2.93	3.26	3.08
14	.0641	2.57	2.61	2.90	2.74
15	.0571	2.29	2.32	2.59	2.44
16	.0508	2.04	2.07	2.30	2.18
17	.0453	1.82	1.84	2.05	1.94
18	.0403	1.62	1.64	1.83	1.73
19	.0359	1.44	1.46	1.63	1.54
20	.0320	1.28	1.30	1.45	1.37
21	.0285	1.14	1.16	1.29	1.22
22	.0253	1.02	1.03	1.15	1.08
23	.0226	.906	.918	1.02	.966
24	.0201	.807	.817	.911	.860
25	.0179	.718	.728	.811	.766
26	.0159	.640	.648	.722	.682
27	.0142	.570	.577	.643	.608
28	.0126	.507	.514	.573	.541
29	.0113	.452	.458	.510	.482
30	.0100	.402	.408	.454	.429
31	.0089	.358	.363	.404	.382
32	.0080	.319	.323	.360	.340
33	.0071	.284	.288	.321	.303
34	.0063	.253	.256	.286	.270
35	.0056	.225	.228	.254	.240

As there are many gauges in use differing from each other, and even he thicknesses of a certain specified gauge, as the Birmingham, are not ssumed the same by all manufacturers, orders for sheets and wire hould *always state the* weight per square foot, or the thickness *ousandths of an inch.*

MENSURATION

LENGTH

Circumference of circle = diameter × 3.1416.
Diameter of circle = circumference × 0.3183.
Side of square of equal periphery as circle = diameter ×
Diameter of circle of equal periphery as square = side ×
Side of an inscribed square = diameter of circle × 0.70
Length of arc = No. of degrees × diameter × 0.008727.
Circumference of circle whose diameter is 1 =

$$\pi = 3.14159265.$$

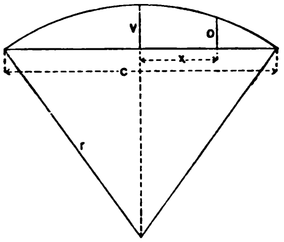
log. $\pi = 0.4971499.$

$\sqrt{\pi} = 1.772454.$

$\pi^2 = 9.869604.$

$$r = \frac{v^2 + \frac{c^2}{4}}{2v}$$

or very nearly $= \frac{c^2}{8v}$



$\frac{1}{\pi} =$

$\frac{1}{\pi^2} =$

$\sqrt{\frac{1}{\pi}} = 0$

$o = \sqrt{r^2 - x^2}$

$$v = r - \sqrt{r^2 - \frac{c^2}{4}} \text{ or very nearly } = \frac{c^2}{8r}.$$

AREA

Triangle = base × half perpendicular height.
Parallelogram = base × perpendicular height.
Trapezoid = half the sum of the parallel sides × perpen height.
Trapezium, found by dividing into two triangles.
Circle = diameter squared × 0.7854; or,
= circumference squared × 0.07958.
Sector of circle = length of arc × half radius.

MENSURATION — Continued

gment of circle = area of sector less triangle; also for flat segments very nearly $= \frac{4v}{3}\sqrt{0.388\,v^2 + \frac{c^2}{4}}$.

le of square of equal area as circle = diameter × 0.8862; also = circumference × 0.2821.

ameter of circle of equal area as square = side × 1.1284.

rabola = base × ⅔ height.

lipse = long diameter × short diameter × 0.7854.

gular polygon = sum of sides × half perpendicular distance from center to sides.

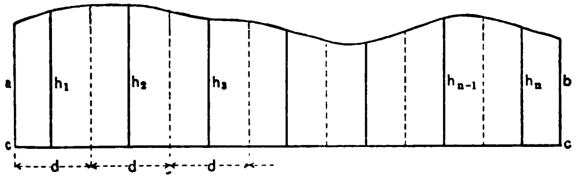
rface of cylinder = circumference × height + area of both ends.

rface of sphere = diameter squared × 3.1416; also = circumference × diameter.

rface of a right pyramid or cone = periphery or circumference of base × half slant height.

rface of a frustrum of a regular right pyramid or cone = sum of peripheries or circumferences of the two ends × half slant height + area of both ends.

The following formulæ are used to obtain the areas of egular plane surfaces which are bounded by a base line "*cc*" d two ordinates "*a*" and "*b*" as per figure.



The formulæ are given in the order of their accuracy be-nning with the most accurate.

The surface is divided into any number (n) of parallel rips having the same widths d and whose middle ordinates represented by h_1 h_2 h_3 .... h_{n-1} and h_n.

MENSURATION—Continued

I. $\text{Area} = d \times \Sigma h + \frac{d}{72}(8a + h_2 - 9h_1) + \frac{d}{72}(8b + h_n$

(Francke'

II. $\text{Area} = d \times \Sigma h + \frac{d}{12}(a - h_1) + \frac{d}{12}(b - h_n)$.

(Poncelet

III. $\text{Area} = d \times \Sigma h$.

These formulæ are more convenient for use than S
rule, and I and II give generally and III sometin
accurate results.

Σ stands for *sum of*.

SOLID CONTENTS

Prism, right or oblique = area of base × perpendicul
Cylinder, right or oblique = area of section at right
sides × length of side.
Sphere = diameter cubed × 0.5236; also = surface ×
eter.
Pyramid or cone, right or oblique, regular or irregul
of base × ⅓ perpendicular height.

PRISMOIDAL FORMULA

A prismoid is a solid bounded by six plane surf
two of which are parallel.

To find the contents of a prismoid, add together th
the two parallel surfaces and four times the are
tion taken midway between and parallel to t
multiply the sum by ⅙th of the perpendicular
between the parallel surfaces.

WEIGHTS AND MEASURES
AVOIRDUPOIS OR ORDINARY COMMERCIAL WEIGHT
UNITED STATES AND BRITISH

Gross Ton	Cwts.	Pounds	Ounces
1.	20.	2240.	35840.
0.050	1.	112.	1792.
	0.0089	1.	16.
		0.0625	1.

1 pound = 27.7 cubic inches of distilled water at its maxi-um density (39° Fahrenheit).

LONG MEASURE
UNITED STATES AND BRITISH

Miles	Rods	Yards	Feet	Inches
1.	320.	1760.	5280.	63360.
0.003125	1.	5.5	16.5	198.
0.000568	0.1818	1.	3.	36.
0.0001894	0.0606	0.3333	1.	12.
0.0000158	0.005051	0.02778	0.08333	1.

The British measures are shorter than those of the U. S. y about 1 part in 17230 or 3.677 inches in a mile.

A fathom = 6 feet. A Gunter's surveying chain = 66 feet r 4 rods, 80 chains making a mile.

SQUARE OR LAND MEASURE
UNITED STATES AND BRITISH

Sq. Miles	Acres	Sq. Rods	Sq. Yards	Sq. Feet	Sq. Inches
1.	640.	102400.	3097600.	27878400.	....
	1.	160.	4840.	43560.	6272640
		1.	30.25	272.25	39204
		0.0331	1.	9.0	1296
			0.111	1.	144
				0.00694	

WEIGHTS AND MEASURES—Continue

CUBIC OR SOLID MEASURE

UNITED STATES AND BRITISH

1728 cubic inches = 1 cubic foot.
27 cubic feet = 1 cubic yard.
A cord of wood = 4′ × 4′ × 8′ = 128 cubic feet.
A perch of masonry = 16.5′ × 1.5′ × 1′ = 24.75 cu
but is generally assumed at 25 cubic feet.

DRY MEASURE

UNITED STATES ONLY

Struck Bush.	Pecks	Quarts	Pints	Gallons
1	4	32.	64	8.
	1	8.	16	2.
		1.	2	0.25
		0.5	1	0.125
		4.	8	1.

A gallon of liquid measure = 231 cubic inches.
A heaped bushel = 1¼ struck bushels. The cc
heaped bushel must be not less than 6 inches high.
A barrel of U. S. hydraulic cement = 300 to 310
ally and of genuine Portland cement = 425 lbs.
To reduce U. S. dry measures to British Imperi
same name divide by 1.032.

NAUTICAL MEASURE

A nautical or sea mile is the length of a minute
tude of the earth at the equator at the level of the se
assumed at 6086.07 feet=1.152664 statute or land mil
United States Coast Survey.
3 nautical miles = 1 league.

METRIC SYSTEM

Linear Measures

...ation	Abbr.	Value	
...eter...	.....	10000	m.
...er.....	km.	1000	"
...eter...	......	100	"
...ter ...	......	10	"
....	m.	1	"
...er	dm.	.1	"
...ter ...	cm.	.01	"
...er	mm.	.001	"

Measures of Surface

Denomination	Abbr.	Value	
Sq. Kilometer	km².	1000000	m².
Hectare.......	ha.	10000	"
Are...........	a.	100	"
Centare.....	......	1	"
Sq. Meter...	m².	1	"
Sq. Decimeter	dm².	.01	"
Sq. Centim ...	cm².	.0001	"
Sq. Millimeter	mm².	.000001	"

Measures of Volume

...ation	Abbr.	Value	
...er	......	1000	l.
....	s.	1000	"
...Meter	m³.	1000	"
...er	hl.	100	"
...r	dal.	10	"
...ecim..	dm³.	1	"
....	l.	1	"
...r......	dl.	.1	"
...r	cl.	.01	"
...ntim..	cm³.	.001	"
...ter....	ml.	.001	"
...imeter	mm³.	.000001	"
...er.....	λ	.001	ml.

Measures of Mass

Denomination	Abbr.	Value	
Millier	......	1000	kg.
Tonneau....	......	1000	"
Metric Ton.	t.	1000	"
Quintal.......	q.	100	"
Myriagram...	......	10	"
Kilogram ...	kg.	1000	g.
Kilo.........	......	1000	"
Hectogram...	......	100	"
Dekagram ...	......	10	"
Gram.........	g.	1	"
Decigram	dg.	.1	"
Centigram ...	cg.	.01	"
Milligram....	mg.	.001	"
Microgram...	γ.	.001	[illegible]

INTERCHANGEABLE TABLES BETWEEN UNITED STATES AND METRIC SYSTEMS

1 Meter=39.37 inches. (Act of Congress.)

LONG MEASURE

No.	64ths of an Inch to Millimeters	Millimeters to 64ths of an Inch	Inches to Centimeters	Centimeters to Inches
1	0.3969	2.5197	2.54	0.3937
2	0.7938	5.0394	5.08	0.7874
3	1.1906	7.5590	7.62	1.1811
4	1.5875	10.0787	10.16	1.5748
5	1.9844	12.5984	12.70	1.9685
6	2.3813	15.1181	15.24	2.3622
7	2.7781	17.6378	17.78	2.7559
8	3.1750	20.1574	20.32	3.1496
9	3.5719	22.6771	22.86	3.5433

No.	Meters to Feet	Feet to Meters	Kilometers to Miles	Miles to Kilometers
1	3.2808	0.3048	0.62137	1.60935
2	6.5617	0.6096	1.24274	3.21869
3	9.8425	0.9144	1.86411	4.82804
4	13.1233	1.2192	2.48548	6.43739
5	16.4042	1.5240	3.10685	8.04674
6	19.6850	1.8288	3.72822	9.65608
7	22.9658	2.1336	4.34959	11.26543
8	26.2467	2.4384	4.97096	12.87478
9	29.5275	2.7432	5.59233	14.48413

INTERCHANGEABLE TABLES BETWEEN NITED STATES AND METRIC SYSTEMS

SQUARE MEASURE

No.	Square Inches to Square Centimeters	Square Centimeters to Square Inches	Square Feet to Square Meters	Square Meters to Square Feet	Square Yards to Square Meters	Square Meters to Square Yards
1	6.4516	0.155	0.0929	10.7639	0.8361	1.196
2	12.9032	0.310	0.1858	21.5278	1.6722	2.392
3	19.3548	0.465	0.2787	32.2917	2.5084	3.588
4	25.8064	0.620	0.3716	43.0556	3.3445	4.784
5	32.2581	0.775	0.4645	53.8194	4.1806	5.980
6	38.7097	0.930	0.5574	64.5833	5.0167	7.176
7	45.1613	1.085	0.6503	75.3472	5.8528	8.372
8	51.6129	1.240	0.7432	86.1111	6.6890	9.568
9	58.0645	1.395	0.8361	96.8750	7.5251	10.764

No.	Acres to Hectares	Hectares to Acres	Square Miles to Square Kilometers	Square Kilometers to Square Miles	Square Miles to Hectares	Hectares to Square Miles
1	0.4047	2.471	2.59	0.3861	259.00	0.00386
2	0.8094	4.942	5.18	0.7722	518.00	0.00772
3	1.2141	7.413	7.77	1.1583	777.01	0.01158
4	1.6188	9.884	10.36	1.5444	1036.01	0.01544
5	2.0235	12.355	12.95	1.9305	1295.02	0.01930
6	2.4282	14.826	15.54	2.3166	1554.02	0.02317
7	2.8329	17.297	18.13	2.7027	1813.03	0.02703
8	3.2376	19.768	20.72	3.0887	2072.03	0.03089
9	3.6422	22.239	23.31	3.4748	2331.04	0.0347

INTERCHANGEABLE TABLES BETWE[illegible]
UNITED STATES AND METRIC SY[illegible]

1 Kilogram = 2.2046 pounds. (Act of Congress.)

WEIGHTS

No.	Kilograms to Ounces Troy	Troy Ounces to Grams	Grains to Milligrams	Grams to Grains	Gross T[illegible] to Metr[illegible] Tons
1	32.1507	31.1035	64.8004	15.432	1.01[illegible]
2	64.3015	62.2070	129.6008	30.864	2.03[illegible]
3	96.4522	93.3104	194.4012	46.296	3.04[illegible]
4	128.6030	124.4139	259.2017	61.728	4.06[illegible]
5	160.7537	155.5174	324.0021	77.160	5.08[illegible]
6	192.9045	186.6209	388.8025	92.592	6.09[illegible]
7	225.0552	217.7244	453.6029	108.024	7.11[illegible]
8	257.2059	248.8278	518.4033	123.456	8.12[illegible]
9	289.3567	279.9313	583.2037	138.888	9.14[illegible]

No.	Avoirdupois Ounces to Grams	Kilograms to Ounces Avoirdupois	Avoirdupois Pounds to Kilograms	Kilograms to Pounds Avoirdupois	Net Ton[illegible] to Metr[illegible] Tons
1	28.3495	35.274	0.4536	2.2046	0.90[illegible]
2	56.6990	70.548	0.9072	4.4092	1.81[illegible]
3	85.0485	105.822	1.3608	6.6138	2.721
4	113.3980	141.096	1.8144	8.8184	3.62[illegible]
5	141.7475	176.370	2.2680	11.0230	4.53[illegible]
6	170.0970	211.644	2.7216	13.2276	5.44[illegible]
7	198.4464	246.918	3.1752	15.4322	6.35[illegible]
8	226.7959	282.192	3.6288	17.6368	7.25[illegible]
9	255.1454	317.466	4.0824	19.8414	8.16[illegible]

INTERCHANGEABLE TABLES BETWEEN UNITED STATES AND METRIC SYSTEMS

1 Liter = 1.0567 Quarts—Liquid Measure. / 0.908 Quarts—Dry Measure. (Act of Congress.)

LIQUID AND DRY MEASURE

No.	Liters to Quarts		Quarts to Liters		Liters to Gallons	Gallons to Liters
	Liquid	Dry	Liquid	Dry	Liquid	Liquid
1	1.0567	0.908	0.9463	1.1013	0.2642	3.7854
2	2.1134	1.816	1.8927	2.2026	0.5284	7.5707
3	3.1701	2.724	2.8390	3.3040	0.7925	11.3561
4	4.2268	3.632	3.7854	4.4053	1.0567	15.1415
5	5.2835	4.540	4.7317	5.5066	1.3209	18.9268
6	6.3402	5.448	5.6781	6.6079	1.5851	22.7122
7	7.3969	6.356	6.6244	7.7093	1.8492	26.4976
8	8.4536	7.264	7.5707	8.8106	2.1134	30.2830
9	9.5103	8.172	8.5171	9.9119	2.3776	34.0683

No.	Cubic Meters to Gallons Liquid	Gallons to Cubic Meters Liquid	Hectoliters to Bushels Dry	Bushels to Hectoliters Dry
1	264.17	0.0038	2.8375	0.3524
2	528.34	0.0076	5.6750	0.7048
3	792.51	0.0114	8.5125	1.0573
4	1056.68	0.0151	11.3500	1.4097
5	1320.85	0.0189	14.1875	1.7621
6	1585.02	0.0227	17.0250	2.1145
7	1849.19	0.0265	19.8625	2.4670
8	2113.36	0.0303	22.7000	2.8194
9	2377.53	0.0341	25.5375	3.1718

INTERCHANGEABLE TABLES BETWE
UNITED STATES AND METRIC SY

CUBIC, HORSE POWER AND TON MEASURE

No.	Cubic Centimeters to Cubic Inches	Cubic Inches to Cubic Centimeters	Cubic Meters to Cubic Feet	Cubic Feet to Cubic Meters	Cubic Meters to Cubic Yards
1	0.061	16.3934	35.316	0.0283	1.308
2	0.122	32.7869	70.632	0.0566	2.616
3	0.183	49.1803	105.948	0.0849	3.924
4	0.244	65.5738	141.264	0.1133	5.232
5	0.305	81.9672	176.580	0.1416	6.540
6	0.366	98.3607	211.896	0.1699	7.848
7	0.427	114.7541	247.212	0.1982	9.156
8	0.488	131.1475	282.528	0.2265	10.464
9	0.549	147.5410	317.844	0.2548	11.772

No.	Horse Power Metric to U. S.	Horse Power U. S. to Metric	Foot-pounds to Kilogram-meters	Kilogram-meters to Foot-pounds	Gross Tons per Sq. F to Metric Tons per Sq. Meter
1	0.986	1.014	0.1383	7.2329	10.93
2	1.973	2.028	0.2765	14.4659	21.87
3	2.959	3.042	0.4148	21.6988	32.81
4	3.945	4.056	0.5530	28.9317	43.74
5	4.932	5.069	0.6913	36.1646	54.68
6	5.918	6.083	0.8295	43.3976	65.62
7	6.904	7.097	0.9678	50.6305	76.55
8	7.890	8.111	1.1061	57.8634	87.49
9	8.877	9.125	1.2443	65.0963	98.43

INTERCHANGEABLE TABLES BETWEEN UNITED STATES AND METRIC SYSTEMS

MISCELLANEOUS

No.	Kilo. per Meter to Pounds per Foot	Pounds per Foot to Kilo. per Meter	Kilo. per Square Meter to Pounds per Square Foot	Pounds per Square Foot to Kilo. per Square Meter
1	0.6720	1.4882	0.2048	4.8825
2	1.3439	2.9764	0.4096	9.7649
3	2.0159	4.4645	0.6144	14.6474
4	2.6879	5.9527	0.8193	19.5299
5	3.3598	7.4409	1.0241	24.4123
6	4.0318	8.9291	1.2289	29.2948
7	4.7037	10.4172	1.4337	34.1773
8	5.3757	11.9054	1.6385	39.0597
9	6.0477	13.3936	1.8433	43.9422

No.	Kilo. per Cubic Meter to Pounds per Cubic Foot	Pounds per Cubic Foot to Kilo. per Cubic Meter	Kilo. per Square Centimeter to Pounds per Square Inch	Pounds per Square Inch to Kilo. per Square Centimeter
1	0.0624	16.0192	14.2232	0.0703
2	0.1248	32.0385	28.4465	0.1406
3	0.1873	48.0577	42.6697	0.2109
4	0.2497	64.0769	56.8929	0.2812
5	0.3121	80.0962	71.1161	0.3515
6	0.3745	96.1154	85.3394	0.4218
7	0.4370	112.1346	99.5626	0.4922
8	0.4994	128.1539	113.7858	0.5625
9	0.5618	144.1731	128.0090	0.6328

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, RE
CIRCUMFERENCES AND CIRCULAR AREAS OF NOS. FROM 1 T

No.	Square	Cube	Sq. Root	Cu. Root	Log.	1000xRecip.	N Circum
1	1	1	1.0000	1.0000	0.00000	1000.000	3.14
2	4	8	1.4142	1.2599	0.30103	500.000	6.28
3	9	27	1.7321	1.4422	0.47712	333.333	9.42
4	16	64	2.0000	1.5874	0.60206	250.000	12.56
5	25	125	2.2361	1.7100	0.69897	200.000	15.70
6	36	216	2.4495	1.8171	0.77815	166.667	18.85
7	49	343	2.6458	1.9129	0.84510	142.857	21.99
8	64	512	2.8284	2.0000	0.90309	125.000	25.13
9	81	729	3.0000	2.0801	0.95424	111.111	28.27
10	100	1000	3.1623	2.1544	1.00000	100.000	31.41
11	121	1331	3.3166	2.2240	1.04139	90.9091	34.55
12	144	1728	3.4641	2.2894	1.07918	83.3333	37.69
13	169	2197	3.6056	2.3513	1.11394	76.9231	40.84
14	196	2744	3.7417	2.4101	1.14613	71.4286	43.98
15	225	3375	3.8730	2.4662	1.17609	66.6667	47.12
16	256	4096	4.0000	2.5198	1.20412	62.5000	50.26
17	289	4913	4.1231	2.5713	1.23045	58.8235	53.40
18	324	5832	4.2426	2.6207	1.25527	55.5556	56.54
19	361	6859	4.3589	2.6684	1.27875	52.6316	59.69
20	400	8000	4.4721	2.7144	1.30103	50.0000	62.83
21	441	9261	4.5826	2.7589	1.32222	47.6190	65.97
22	484	10648	4.6904	2.8020	1.34242	45.4545	69.11
23	529	12167	4.7958	2.8439	1.36173	43.4783	72.25
24	576	13824	4.8990	2.8845	1.38021	41.6667	75.39
25	625	15625	5.0000	2.9240	1.39794	40.0000	78.54
26	676	17576	5.0990	2.9625	1.41497	38.4615	81.68
27	729	19683	5.1962	3.0000	1.43136	37.0370	84.82
28	784	21952	5.2915	3.0366	1.44716	35.7143	87.96
29	841	24389	5.3852	3.0723	1.46240	34.4828	91.10
30	900	27000	5.4772	3.1072	1.47712	33.3333	94.24
31	961	29791	5.5678	3.1414	1.49136	32.2581	97.38
32	1024	32768	5.6569	3.1748	1.50515	31.2500	100.53
33	1089	35937	5.7446	3.2075	1.51851	30.3030	103.67
34	1156	39304	5.8310	3.2396	1.53148	29.4118	106.81
35	1225	42875	5.9161	3.2711	1.54407	28.5714	109.95
36	1296	46656	6.0000	3.3019	1.55630	27.7778	113.09
37	1369	50653	6.0828	3.3322	1.56820	27.0270	116.23
38	1444	54872	6.1644	3.3620	1.57978	26.3158	119.38
39	1521	59319	6.2450	3.3912	1.59106	25.6410	122.52
40	1600	64000	6.3246	3.4200	1.60206	25.0000	125.66
41	1681	68921	6.4031	3.4482	1.61278	24.3902	128.81
42	1764	74088	6.4807	3.4760	1.62325	23.8095	131.95
43	1849	79507	6.5574	3.5034	1.63347	23.2558	135.09
44	1936	85184	6.6332	3.5303	1.64345	22.7273	138.23
45	2025	91125	6.7082	3.5569	1.65321	22.2222	141.37
46	2116	97336	6.7823	3.5830	1.66276	21.7391	144.51
47	2209	103823	6.8557	3.6088	1.67210	21.2766	147.65
48	2304	110592	6.9282	3.6342	1.68124	20.8333	150.80
49	2401	117649	7.0000	3.6593	1.69020	20.4082	153.9

ARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, RECIPROCALS, CIRCUMFERENCES AND CIRCULAR AREAS OF NOS. FROM 1 TO 1000

Square	Cube	Sq. Root	Cu. Root	Log.	1000xRecip.	No. = Dia.	
						Circum.	Area
2500	125000	7.0711	3.6840	1.69897	20.0000	157.08	1963.50
2601	132651	7.1414	3.7084	1.70757	19.6078	160.22	2042.82
2704	140608	7.2111	3.7325	1.71600	19.2308	163.36	2123.72
2809	148877	7.2801	3.7563	1.72428	18.8679	166.50	2206.18
2916	157464	7.3485	3.7798	1.73239	18.5185	169.65	2290.22
3025	166375	7.4162	3.8030	1.74036	18.1818	172.79	2375.83
3136	175616	7.4833	3.8259	1.74819	17.8571	175.93	2463.01
3249	185193	7.5498	3.8485	1.75587	17.5439	179.07	2551.76
3364	195112	7.6158	3.8709	1.76343	17.2414	182.21	2642.08
3481	205379	7.6811	3.8930	1.77085	16.9492	185.35	2733.97
3600	216000	7.7460	3.9149	1.77815	16.6667	188.50	2827.43
3721	226981	7.8102	3.9365	1.78533	16.3934	191.64	2922.47
3844	238328	7.8740	3.9579	1.79239	16.1290	194.78	3019.07
3969	250047	7.9373	3.9791	1.79934	15.8730	197.92	3117.25
4096	262144	8.0000	4.0000	1.80618	15.6250	201.06	3216.99
4225	274625	8.0623	4.0207	1.81291	15.3846	204.20	3318.31
4356	287496	8.1240	4.0412	1.81954	15.1515	207.35	3421.19
4489	300763	8.1854	4.0615	1.82607	14.9254	210.49	3525.65
4624	314432	8.2462	4.0817	1.83251	14.7059	213.63	3631.68
4761	328509	8.3066	4.1016	1.83885	14.4928	216.77	3739.28
4900	343000	8.3666	4.1213	1.84510	14.2857	219.91	3848.45
5041	357911	8.4261	4.1408	1.85126	14.0845	223.05	3959.19
5184	373248	8.4853	4.1602	1.85733	13.8889	226.19	4071.50
5329	389017	8.5440	4.1793	1.86332	13.6986	229.34	4185.39
5476	405224	8.6023	4.1983	1.86923	13.5135	232.48	4300.84
5625	421875	8.6603	4.2172	1.87506	13.3333	235.62	4417.86
5776	438976	8.7178	4.2358	1.88081	13.1579	238.76	4536.46
5929	456533	8.7750	4.2543	1.88649	12.9870	241.90	4656.63
6084	474552	8.8318	4.2727	1.89209	12.8205	245.04	4778.36
6241	493039	8.8882	4.2908	1.89763	12.6582	248.19	4901.67
6400	512000	8.9443	4.3089	1.90309	12.5000	251.33	5026.55
6561	531441	9.0000	4.3267	1.90849	12.3457	254.47	5153.00
6724	551368	9.0554	4.3445	1.91381	12.1951	257.61	5281.02
6889	571787	9.1104	4.3621	1.91908	12.0482	260.75	5410.61
7056	592704	9.1652	4.3795	1.92428	11.9048	263.89	5541.77
7225	614125	9.2195	4.3968	1.92942	11.7647	267.04	5674.50
7396	636056	9.2736	4.4140	1.93450	11.6279	270.18	5808.80
7569	658503	9.3274	4.4310	1.93952	11.4943	273.32	5944.68
7744	681472	9.3808	4.4480	1.94448	11.3636	276.46	6082.12
7921	704969	9.4340	4.4647	1.94939	11.2360	279.60	6221.14
8100	729000	9.4868	4.4814	1.95424	11.1111	282.74	6361.73
8281	753571	9.5394	4.4979	1.95904	10.9890	285.88	6503.88
8464	778688	9.5917	4.5144	1.96379	10.8696	289.03	6647.61
8649	804357	9.6437	4.5307	1.96848	10.7527	292.17	6792.91
8836	830584	9.6954	4.5468	1.97313	10.6383	295.31	6939.78
9025	857375	9.7468	4.5629	1.97772	10.5263	298.45	7088.22
9216	884736	9.7980	4.5789	1.98227	10.4167	301.59	7238.23
9409	912673	9.8489	4.5947	1.98677	10.3093	304.73	7389.81
9604	941192	9.8995	4.6104	1.99123	10.2041	307.88	7542.96
9801	970299	9.9499	4.6261	1.99564	10.1010	311.02	7697.69

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, RECI
CIRCUMFERENCES AND CIRCULAR AREAS OF NOS. FROM 1 TO 1

No.	Square	Cube	Sq. Root	Cu. Root	Log.	1000xRecip.	No. =
							Circum.
100	10000	1000000	10.0000	4.6416	2.00000	10.0000	314.16
101	10201	1030301	10.0499	4.6570	2.00432	9.90099	317.30
102	10404	1061208	10.0995	4.6723	2.00860	9.80392	320.44
103	10609	1092727	10.1489	4.6875	2.01284	9.70874	323.58
104	10816	1124864	10.1980	4.7027	2.01703	9.61538	326.73
105	11025	1157625	10.2470	4.7177	2.02119	9.52381	329.87
106	11236	1191016	10.2956	4.7326	2.02531	9.43396	333.01
107	11449	1225043	10.3441	4.7475	2.02938	9.34579	336.15
108	11664	1259712	10.3923	4.7622	2.03342	9.25926	339.29
109	11881	1295029	10.4403	4.7769	2.03743	9.17431	342.43
110	12100	1331000	10.4881	4.7914	2.04139	9.09091	345.58
111	12321	1367631	10.5357	4.8059	2.04532	9.00901	348.72
112	12544	1404928	10.5830	4.8203	2.04922	8.92857	351.86
113	12769	1442897	10.6301	4.8346	2.05308	8.84956	355.00
114	12996	1481544	10.6771	4.8488	2.05690	8.77193	358.14
115	13225	1520875	10.7238	4.8629	2.06070	8.69565	361.28
116	13456	1560896	10.7703	4.8770	2.06446	8.62069	364.42
117	13689	1601613	10.8167	4.8910	2.06819	8.54701	367.57
118	13924	1643032	10.8628	4.9049	2.07188	8.47458	370.71
119	14161	1685159	10.9087	4.9187	2.07555	8.40336	373.85
120	14400	1728000	10.9545	4.9324	2.07918	8.33333	376.99
121	14641	1771561	11.0000	4.9461	2.08279	8.26446	380.13
122	14884	1815848	11.0454	4.9597	2.08636	8.19672	383.27
123	15129	1860867	11.0905	4.9732	2.08991	8.13008	386.42
124	15376	1906624	11.1355	4.9866	2.09342	8.06452	389.56
125	15625	1953125	11.1803	5.0000	2.09691	8.00000	392.70
126	15876	2000376	11.2250	5.0133	2.10037	7.93651	395.8
127	16129	2048383	11.2694	5.0265	2.10380	7.87402	398.9
128	16384	2097152	11.3137	5.0397	2.10721	7.81250	402.1
129	16641	2146689	11.3578	5.0528	2.11059	7.75194	405.2
130	16900	2197000	11.4018	5.0658	2.11394	7.69231	408.4
131	17161	2248091	11.4455	5.0788	2.11727	7.63359	411.5
132	17424	2299968	11.4891	5.0916	2.12057	7.57576	414.6
133	17689	2352637	11.5326	5.1045	2.12385	7.51880	417.8
134	17956	2406104	11.5758	5.1172	2.12710	7.46269	420.9
135	18225	2460375	11.6190	5.1299	2.13033	7.40741	424.1
136	18496	2515456	11.6619	5.1426	2.13354	7.35294	427.2
137	18769	2571353	11.7047	5.1551	2.13672	7.29927	430.4
138	19044	2628072	11.7473	5.1676	2.13988	7.24638	433.5
139	19321	2685619	11.7898	5.1801	2.14301	7.19424	436.6
140	19600	2744000	11.8322	5.1925	2.14613	7.14286	439.8
141	19881	2803221	11.8743	5.2048	2.14922	7.09220	442.9
142	20164	2863288	11.9164	5.2171	2.15229	7.04225	446.11
143	20449	2924207	11.9583	5.2293	2.15534	6.99301	449.25
144	20736	2985984	12.0000	5.2415	2.15836	6.94444	452.39
145	21025	3048625	12.0416	5.2536	2.16137	6.89655	455.53
146	21316	3112136	12.0830	5.2656	2.16435	6.84932	458.67
147	21609	3176523	12.1244	5.2776	2.16732	6.80272	461.81
148	21904	3241792	12.1655	5.2896	2.17026	6.75676	464.96
149	22201	3307949	12.2066	5.3015	2.17319	6.71141	468.10

CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, RECIPROCALS, UMFERENCES AND CIRCULAR AREAS OF NOS. FROM 1 TO 1000

e	Cube	Sq. Root	Cu. Root	Log.	1000xRecip.	No. = Dia.	
						Circum.	Area
0	3375000	12.2474	5.3133	2.17609	6.66667	471.24	17671.5
1	3442951	12.2882	5.3251	2.17898	6.62252	474.38	17907.9
4	3511808	12.3288	5.3368	2.18184	6.57895	477.52	18145.8
9	3581577	12.3693	5.3485	2.18469	6.53595	480.66	18385.4
6	3652264	12.4097	5.3601	2.18752	6.49351	483.81	18626.5
5	3723875	12.4499	5.3717	2.19033	6.45161	486.95	18869.2
6	3796416	12.4900	5.3832	2.19312	6.41026	490.09	19113.4
9	3869893	12.5300	5.3947	2.19590	6.36943	493.23	19359.3
4	3944312	12.5698	5.4061	2.19866	6.32911	496.37	19606.7
1	4019679	12.6095	5.4175	2.20140	6.28931	499.51	19855.7
0	4096000	12.6491	5.4288	2.20412	6.25000	502.65	20106.2
1	4173281	12.6886	5.4401	2.20683	6.21118	505.80	20358.3
4	4251528	12.7279	5.4514	2.20952	6.17284	508.94	20612.0
9	4330747	12.7671	5.4626	2.21219	6.13497	512.08	20867.2
6	4410944	12.8062	5.4737	2.21484	6.09756	515.22	21124.1
5	4492125	12.8452	5.4848	2.21748	6.06061	518.36	21382.5
6	4574296	12.8841	5.4959	2.22011	6.02410	521.50	21642.4
9	4657463	12.9228	5.5069	2.22272	5.98802	524.65	21904.0
4	4741632	12.9615	5.5178	2.22531	5.95238	527.79	22167.1
1	4826809	13.0000	5.5288	2.22789	5.91716	530.93	22431.8
0	4913000	13.0384	5.5397	2.23045	5.88235	534.07	22698.0
1	5000211	13.0767	5.5505	2.23300	5.84795	537.21	22965.8
4	5088448	13.1149	5.5613	2.23553	5.81395	540.35	23235.2
9	5177717	13.1529	5.5721	2.23805	5.78035	543.50	23506.2
6	5268024	13.1909	5.5828	2.24055	5.74713	546.64	23778.7
5	5359375	13.2288	5.5934	2.24304	5.71429	549.78	24052.8
6	5451776	13.2665	5.6041	2.24551	5.68182	552.92	24328.5
9	5545233	13.3041	5.6147	2.24797	5.64972	556.06	24605.7
4	5639752	13.3417	5.6252	2.25042	5.61798	559.20	24884.6
1	5735339	13.3791	5.6357	2.25285	5.58659	562.35	25164.9
0	5832000	13.4164	5.6462	2.25527	5.55556	565.49	25446.9
1	5929741	13.4536	5.6567	2.25768	5.52486	568.63	25730.4
4	6028568	13.4907	5.6671	2.26007	5.49451	571.77	26015.5
9	6128487	13.5277	5.6774	2.26245	5.46448	574.91	26302.2
6	6229504	13.5647	5.6877	2.26482	5.43478	578.05	26590.4
5	6331625	13.6015	5.6980	2.26717	5.40541	581.19	26880.3
6	6434856	13.6382	5.7083	2.26951	5.37634	584.34	27171.6
9	6539203	13.6748	5.7185	2.27184	5.34759	587.48	27464.6
4	6644672	13.7113	5.7287	2.27416	5.31915	590.62	27759.1
1	6751269	13.7477	5.7388	2.27646	5.29101	593.76	28055.2
0	6859000	13.7840	5.7489	2.27875	5.26316	596.90	28352.9
1	6967871	13.8203	5.7590	2.28103	5.23560	600.04	28652.1
4	7077888	13.8564	5.7690	2.28330	5.20833	603.19	28952.9
9	7189057	13.8924	5.7790	2.28556	5.18135	606.33	29255.3
6	7301384	13.9284	5.7890	2.28780	5.15464	609.47	29559.2
5	7414875	13.9642	5.7989	2.29003	5.12821	612.61	29864.8
6	7529536	14.0000	5.8088	2.29226	5.10204	615.75	30171.9
9	7645373	14.0357	5.8186	2.29447	5.07614	618.89	30480.5
04	7762392	14.0712	5.8285	2.29667	5.05051	622.04	30790.7
01	7880599	14.1067	5.8383	2.29885	5.02513	625.18	31102.6

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, RECI…
CIRCUMFERENCES AND CIRCULAR AREAS OF NOS. FROM 1 TO 1…

No.	Square	Cube	Sq. Root	Cu. Root	Log.	1000xRecip.	No. Circum.
200	40000	8000000	14.1421	5.8480	2.30103	5.00000	628.3…
201	40401	8120601	14.1774	5.8578	2.30320	4.97512	631.4…
202	40804	8242408	14.2127	5.8675	2.30535	4.95050	634.6…
203	41209	8365427	14.2478	5.8771	2.30750	4.92611	637.7…
204	41616	8489664	14.2829	5.8868	2.30963	4.90196	640.8…
205	42025	8615125	14.3178	5.8964	2.31175	4.87805	644.0…
206	42436	8741816	14.3527	5.9059	2.31387	4.85437	647.1…
207	42849	8869743	14.3875	5.9155	2.31597	4.83092	650.3…
208	43264	8998912	14.4222	5.9250	2.31806	4.80769	653.4…
209	43681	9129329	14.4568	5.9345	2.32015	4.78469	656.5…
210	44100	9261000	14.4914	5.9439	2.32222	4.76190	659.7…
211	44521	9393931	14.5258	5.9533	2.32428	4.73934	662.8…
212	44944	9528128	14.5602	5.9627	2.32634	4.71698	666.0…
213	45369	9663597	14.5945	5.9721	2.32838	4.69484	669.1…
214	45796	9800344	14.6287	5.9814	2.33041	4.67290	672.3…
215	46225	9938375	14.6629	5.9907	2.33244	4.65116	675.4…
216	46656	10077696	14.6969	6.0000	2.33445	4.62963	678.5…
217	47089	10218313	14.7309	6.0092	2.33646	4.60829	681.7…
218	47524	10360232	14.7648	6.0185	2.33846	4.58716	684.8…
219	47961	10503459	14.7986	6.0277	2.34044	4.56621	688.0…
220	48400	10648000	14.8324	6.0368	2.34242	4.54545	691.1…
221	48841	10793861	14.8661	6.0459	2.34439	4.52489	694.2…
222	49284	10941048	14.8997	6.0550	2.34635	4.50450	697.4…
223	49729	11089567	14.9332	6.0641	2.34830	4.48431	700.5…
224	50176	11239424	14.9666	6.0732	2.35025	4.46429	703.7…
225	50625	11390625	15.0000	6.0822	2.35218	4.44444	706.8…
226	51076	11543176	15.0333	6.0912	2.35411	4.42478	710.0…
227	51529	11697083	15.0665	6.1002	2.35603	4.40529	713.1…
228	51984	11852352	15.0997	6.1091	2.35793	4.38596	716.2…
229	52441	12008989	15.1327	6.1180	2.35984	4.36681	719.4…
230	52900	12167000	15.1658	6.1269	2.36173	4.34783	722.5…
231	53361	12326391	15.1987	6.1358	2.36361	4.32900	725.7…
232	53824	12487168	15.2315	6.1446	2.36549	4.31034	728.8…
233	54289	12649337	15.2643	6.1534	2.36736	4.29185	731.9…
234	54756	12812904	15.2971	6.1622	2.36922	4.27350	735.1…
235	55225	12977875	15.3297	6.1710	2.37107	4.25532	738.2…
236	55696	13144256	15.3623	6.1797	2.37291	4.23729	741.4…
237	56169	13312053	15.3948	6.1885	2.37475	4.21941	744.5…
238	56644	13481272	15.4272	6.1972	2.37658	4.20168	747.7…
239	57121	13651919	15.4596	6.2058	2.37840	4.18410	750.8…
240	57600	13824000	15.4919	6.2145	2.38021	4.16667	753.9…
241	58081	13997521	15.5242	6.2231	2.38202	4.14938	757.1…
242	58564	14172488	15.5563	6.2317	2.38382	4.13223	760.2…
243	59049	14348907	15.5885	6.2403	2.38561	4.11523	763.41…
244	59536	14526784	15.6205	6.2488	2.38739	4.09836	766.5…
245	60025	14706125	15.6525	6.2573	2.38917	4.08163	769.6…
246	60516	14886936	15.6844	6.2658	2.39094	4.06504	772.8…
247	61009	15069223	15.7162	6.2743	2.39270	4.04858	775.9…
[illegible]	61504	15252992	15.7480	6.2828	2.39445	4.03226	779.1…
[illegible]	62001	15438249	15.7797	6.2912	2.39620	4.01606	782.3…

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, RECIPROCALS CIRCUMFERENCES AND CIRCULAR AREAS OF NOS. FROM 1 TO 1000

No.	Square	Cube	Sq. Root	Cu. Root	Log.	1000×Recip.	No. = Dia.	
							Circum.	Area
250	62500	15625000	15.8114	6.2996	2.39794	4.00000	785.40	49087.
251	63001	15813251	15.8430	6.3080	2.39967	3.98406	788.54	49480.
252	63504	16003008	15.8745	6.3164	2.40140	3.96825	791.68	49875.
253	64009	16194277	15.9060	6.3247	2.40312	3.95257	794.82	50272.
254	64516	16387064	15.9374	6.3330	2.40483	3.93701	797.96	50670.
255	65025	16581375	15.9687	6.3413	2.40654	3.92157	801.11	51070.
256	65536	16777216	16.0000	6.3496	2.40824	3.90625	804.25	51471.
257	66049	16974593	16.0312	6.3579	2.40993	3.89105	807.39	51874.
258	66564	17173512	16.0624	6.3661	2.41162	3.87597	810.53	52279.
259	67081	17373979	16.0935	6.3743	2.41330	3.86100	813.67	52685.
260	67600	17576000	16.1245	6.3825	2.41497	3.84615	816.81	53092.
261	68121	17779581	16.1555	6.3907	2.41664	3.83142	819.96	53502.
262	68644	17984728	16.1864	6.3988	2.41830	3.81679	823.10	53912.
263	69169	18191447	16.2173	6.4070	2.41996	3.80228	826.24	54325.
264	69696	18399744	16.2481	6.4151	2.42160	3.78788	829.38	54739.
265	70225	18609625	16.2788	6.4232	2.42325	3.77358	832.52	55154.
266	70756	18821096	16.3095	6.4312	2.42488	3.75940	835.66	55571.
267	71289	19034163	16.3401	6.4393	2.42651	3.74532	838.81	55990.
268	71824	19248832	16.3707	6.4473	2.42813	3.73134	841.95	56410.
269	72361	19465109	16.4012	6.4553	2.42975	3.71747	845.09	56832.
270	72900	19683000	16.4317	6.4633	2.43136	3.70370	848.23	57255.
271	73441	19902511	16.4621	6.4713	2.43297	3.69004	851.37	57680.
272	73984	20123648	16.4924	6.4792	2.43457	3.67647	854.51	58106.
273	74529	20346417	16.5227	6.4872	2.43616	3.66300	857.66	58534.
274	75076	20570824	16.5529	6.4951	2.43775	3.64964	860.80	58964.
275	75625	20796875	16.5831	6.5030	2.43933	3.63636	863.94	59395.
276	76176	21024576	16.6132	6.5108	2.44091	3.62319	867.08	59828.
277	76729	21253933	16.6433	6.5187	2.44248	3.61011	870.22	60262.
278	77284	21484952	16.6733	6.5265	2.44404	3.59712	873.36	60698.
279	77841	21717639	16.7033	6.5343	2.44560	3.58423	876.50	61136.
280	78400	21952000	16.7332	6.5421	2.44716	3.57143	879.65	61575.
281	78961	22188041	16.7631	6.5499	2.44871	3.55872	882.79	62015.
282	79524	22425768	16.7929	6.5577	2.45025	3.54610	885.93	62458.
283	80089	22665187	16.8226	6.5654	2.45179	3.53357	889.07	62901.
284	80656	22906304	16.8523	6.5731	2.45332	3.52113	892.21	63347.
285	81225	23149125	16.8819	6.5808	2.45484	3.50877	895.35	63794.
286	81796	23393656	16.9115	6.5885	2.45637	3.49650	898.50	64242.
287	82369	23639903	16.9411	6.5962	2.45788	3.48432	901.64	64692.
288	82944	23887872	16.9706	6.6039	2.45939	3.47222	904.78	65144.
289	83521	24137569	17.0000	6.6115	2.46090	3.46021	907.92	65597.
290	84100	24389000	17.0294	6.6191	2.46240	3.44828	911.06	66052.
291	84681	24642171	17.0587	6.6267	2.46389	3.43643	914.20	66508.
292	85264	24897088	17.0880	6.6343	2.46538	3.42466	917.35	66966.
293	85849	25153757	17.1172	6.6419	2.46687	3.41297	920.49	67425.
294	86436	25412184	17.1464	6.6494	2.46835	3.40136	923.63	67886.
295	87025	25672375	17.1756	6.6569	2.46982	3.38983	926.77	68349.
296	87616	25934336	17.2047	6.6644	2.47129	3.37838	929.91	68813.
297	88209	26198073	17.2337	6.6719	2.47276	3.36700	933.05	69279.
298	88804	26463592	17.2627	6.6794	2.47422	3.35570	936.19	69748
299	89401	26730899	17.2916	6.6869	2.47567	3.34448	939.34	[illegible]

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, RECI[illegible] CIRCUMFERENCES AND CIRCULAR AREAS OF NOS. FROM 1 TO [illegible]

No.	Square	Cube	Sq. Root	Cu. Root	Log.	1000×Recip.	Circum[illegible]
200	40000	8000000	14.1421	5.8480	2.30103	5.00000	628.[illegible]
201	40401	8120601	14.1774	5.8578	2.30320	4.97512	631.4[illegible]
202	40804	8242408	14.2127	5.8675	2.30535	4.95050	634.[illegible]
203	41209	8365427	14.2478	5.8771	2.30750	4.92611	637.[illegible]
204	41616	8489664	14.2829	5.8868	2.30963	4.90196	640.8[illegible]
205	42025	8615125	14.3178	5.8964	2.31175	4.87805	644.[illegible]
206	42436	8741816	14.3527	5.9059	2.31387	4.85437	647.[illegible]
207	42849	8869743	14.3875	5.9155	2.31597	4.83092	650.[illegible]
208	43264	8998912	14.4222	5.9250	2.31806	4.80769	653.[illegible]
209	43681	9129329	14.4568	5.9345	2.32015	4.78469	656.[illegible]
210	44100	9261000	14.4914	5.9439	2.32222	4.76190	659.[illegible]
211	44521	9393931	14.5258	5.9533	2.32428	4.73934	662.[illegible]
212	44944	9528128	14.5602	5.9627	2.32634	4.71698	666.[illegible]
213	45369	9663597	14.5945	5.9721	2.32838	4.69484	669.1[illegible]
214	45796	9800344	14.6287	5.9814	2.33041	4.67290	672.[illegible]
215	46225	9938375	14.6629	5.9907	2.33244	4.65116	675.[illegible]
216	46656	10077696	14.6969	6.0000	2.33445	4.62963	678.[illegible]
217	47089	10218313	14.7309	6.0092	2.33646	4.60829	681.[illegible]
218	47524	10360232	14.7648	6.0185	2.33846	4.58716	684.[illegible]
219	47961	10503459	14.7986	6.0277	2.34044	4.56621	688.[illegible]
220	48400	10648000	14.8324	6.0368	2.34242	4.54545	691.1[illegible]
221	48841	10793861	14.8661	6.0459	2.34439	4.52489	694.[illegible]
222	49284	10941048	14.8997	6.0550	2.34635	4.50450	697.[illegible]
223	49729	11089567	14.9332	6.0641	2.34830	4.48431	700.[illegible]
224	50176	11239424	14.9666	6.0732	2.35025	4.46429	703.[illegible]
225	50625	11390625	15.0000	6.0822	2.35218	4.44444	706.[illegible]
226	51076	11543176	15.0333	6.0912	2.35411	4.42478	710.[illegible]
227	51529	11697083	15.0665	6.1002	2.35603	4.40529	713.[illegible]
228	51984	11852352	15.0997	6.1091	2.35793	4.38596	716.[illegible]
229	52441	12008989	15.1327	6.1180	2.35984	4.36681	719.[illegible]
230	52900	12167000	15.1658	6.1269	2.36173	4.34783	722.[illegible]
231	53361	12326391	15.1987	6.1358	2.36361	4.32900	725.[illegible]
232	53824	12487168	15.2315	6.1446	2.36549	4.31034	728.[illegible]
233	54289	12649337	15.2643	6.1534	2.36736	4.29185	731.[illegible]
234	54756	12812904	15.2971	6.1622	2.36922	4.27350	735.[illegible]
235	55225	12977875	15.3297	6.1710	2.37107	4.25532	738.[illegible]
236	55696	13144256	15.3623	6.1797	2.37291	4.23729	741.[illegible]
237	56169	13312053	15.3948	6.1885	2.37475	4.21941	744.[illegible]
238	56644	13481272	15.4272	6.1972	2.37658	4.20168	747.[illegible]
239	57121	13651919	15.4596	6.2058	2.37840	4.18410	750.[illegible]
240	57600	13824000	15.4919	6.2145	2.38021	4.16667	753.[illegible]
241	58081	13997521	15.5242	6.2231	2.38202	4.14938	757.[illegible]
242	58564	14172488	15.5563	6.2317	2.38382	4.13223	760.[illegible]
243	59049	14348907	15.5885	6.2403	2.38561	4.11523	763.[illegible]
244	59536	14526784	15.6205	6.2488	2.38739	4.09836	766.[illegible]
245	60025	14706125	15.6525	6.2573	2.38917	4.08163	769.[illegible]
246	60516	14886936	15.6844	6.2658	2.39094	4.06504	772.[illegible]
247	61009	15069223	15.7162	6.2743	2.39270	4.04858	775.[illegible]
248	61504	15252992	15.7480	6.2828	2.39445	4.03226	779.[illegible]
249	62001	15438249	15.7797	6.2912	2.39620	4.01606	782.[illegible]

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, RECI
CIRCUMFERENCES AND CIRCULAR AREAS OF NOS. FROM 1 TO 1

No.	Square	Cube	Sq. Root	Cu. Root	Log.	1000xRecip.	No. Circum
400	160000	64000000	20.0000	7.3681	2.60206	2.50000	1256.
401	160801	64481201	20.0250	7.3742	2.60314	2.49377	1259.
402	161604	64964808	20.0499	7.3803	2.60423	2.48756	1262.
403	162409	65450827	20.0749	7.3864	2.60531	2.48139	1266.
404	163216	65939264	20.0998	7.3925	2.60638	2.47525	1269.
405	164025	66430125	20.1246	7.3986	2.60746	2.46914	1272.
406	164836	66923416	20.1494	7.4047	2.60853	2.46305	1275.
407	165649	67419143	20.1742	7.4108	2.60959	2.45700	1278.
408	166464	67917312	20.1990	7.4169	2.61066	2.45098	1281.
409	167281	68417929	20.2237	7.4229	2.61172	2.44499	1284.
410	168100	68921000	20.2485	7.4290	2.61278	2.43902	1288.
411	168921	69426531	20.2731	7.4350	2.61384	2.43309	1291.
412	169744	69934528	20.2978	7.4410	2.61490	2.42718	1294.
413	170569	70444997	20.3224	7.4470	2.61595	2.42131	1297.
414	171396	70957944	20.3470	7.4530	2.61700	2.41546	1300.
415	172225	71473375	20.3715	7.4590	2.61805	2.40964	1303.
416	173056	71991296	20.3961	7.4650	2.61909	2.40385	1306.
417	173889	72511713	20.4206	7.4710	2.62014	2.39808	1310.
418	174724	73034632	20.4450	7.4770	2.62118	2.39234	1313.
419	175561	73560059	20.4695	7.4829	2.62221	2.38664	1316.
420	176400	74088000	20.4939	7.4889	2.62325	2.38095	1319.
421	177241	74618461	20.5183	7.4948	2.62428	2.37530	1322.
422	178084	75151448	20.5426	7.5007	2.62531	2.36967	1325.
423	178929	75686967	20.5670	7.5067	2.62634	2.36407	1328.
424	179776	76225024	20.5913	7.5126	2.62737	2.35849	1332.
425	180625	76765625	20.6155	7.5185	2.62839	2.35294	1335.
426	181476	77308776	20.6398	7.5244	2.62941	2.34742	1338.
427	182329	77854483	20.6640	7.5302	2.63043	2.34192	1341.
428	183184	78402752	20.6882	7.5361	2.63144	2.33645	1344.
429	184041	78953589	20.7123	7.5420	2.63246	2.33100	1347.
430	184900	79507000	20.7364	7.5478	2.63347	2.32558	1350.
431	185761	80062991	20.7605	7.5537	2.63448	2.32019	1354.
432	186624	80621568	20.7846	7.5595	2.63548	2.31482	1357.
433	187489	81182737	20.8087	7.5654	2.63649	2.30947	1360.
434	188356	81746504	20.8327	7.5712	2.63749	2.30415	1363.
435	189225	82312875	20.8567	7.5770	2.63849	2.29885	1366.
436	190096	82881856	20.8806	7.5828	2.63949	2.29358	1369.
437	190969	83453453	20.9045	7.5886	2.64048	2.28833	1372.
438	191844	84027672	20.9284	7.5944	2.64147	2.28311	1376.
439	192721	84604519	20.9523	7.6001	2.64246	2.27790	1379.
440	193600	85184000	20.9762	7.6059	2.64345	2.27273	1382.
441	194481	85766121	21.0000	7.6117	2.64444	2.26757	1385.
442	195364	86350888	21.0238	7.6174	2.64542	2.26244	1388.
443	196249	86938307	21.0476	7.6232	2.64640	2.25734	1391.
444	197136	87528384	21.0713	7.6289	2.64738	2.25225	1394.
445	198025	88121125	21.0950	7.6346	2.64836	2.24719	1398.
446	198916	88716536	21.1187	7.6403	2.64933	2.24215	1401.
447	199809	89314623	21.1424	7.6460	2.65031	2.23714	1404.
448	200704	89915392	21.1660	7.6517	2.65128	2.23214	1407.
9	201601	90518849	21.1896	7.6574	2.65225	2.22717	1410.

RES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, RECIPROCALS, CIRCUMFERENCES AND CIRCULAR AREAS OF NOS. FROM 1 TO 1000

Square	Cube	Sq. Root	Cu. Root	Log.	1000×Recip.	No. = Dia.	
						Circum.	Area
202500	91125000	21.2132	7.6631	2.65321	2.22222	1413.7	159043
203401	91733851	21.2368	7.6688	2.65418	2.21730	1416.9	159751
204304	92345408	21.2603	7.6744	2.65514	2.21239	1420.0	160460
205209	92959677	21.2838	7.6801	2.65610	2.20751	1423.1	161171
206116	93576664	21.3073	7.6857	2.65706	2.20264	1426.3	161883
207025	94196375	21.3307	7.6914	2.65801	2.19780	1429.4	162597
207936	94818816	21.3542	7.6970	2.65896	2.19298	1432.6	163313
208849	95443993	21.3776	7.7026	2.65992	2.18818	1435.7	164030
209764	96071912	21.4009	7.7082	2.66087	2.18341	1438.9	164748
210681	96702579	21.4243	7.7138	2.66181	2.17865	1442.0	165468
211600	97336000	21.4476	7.7194	2.66276	2.17391	1445.1	166190
212521	97972181	21.4709	7.7250	2.66370	2.16920	1448.3	166914
213444	98611128	21.4942	7.7306	2.66464	2.16450	1451.4	167639
214369	99252847	21.5174	7.7362	2.66558	2.15983	1454.6	168365
215296	99897344	21.5407	7.7418	2.66652	2.15517	1457.7	169093
216225	100544625	21.5639	7.7473	2.66745	2.15054	1460.8	169823
217156	101194696	21.5870	7.7529	2.66839	2.14592	1464.0	170554
218089	101847563	21.6102	7.7584	2.66932	2.14133	1467.1	171287
219024	102503232	21.6333	7.7639	2.67025	2.13675	1470.3	172021
219961	103161709	21.6564	7.7695	2.67117	2.13220	1473.4	172757
220900	103823000	21.6795	7.7750	2.67210	2.12766	1476.5	173494
221841	104487111	21.7025	7.7805	2.67302	2.12314	1479.7	174234
222784	105154048	21.7256	7.7860	2.67394	2.11864	1482.8	174974
223729	105823817	21.7486	7.7915	2.67486	2.11417	1486.0	175716
224676	106496424	21.7715	7.7970	2.67578	2.10971	1489.1	176460
225625	107171875	21.7945	7.8025	2.67669	2.10526	1492.3	177205
226576	107850176	21.8174	7.8079	2.67761	2.10084	1495.4	177952
227529	108531333	21.8403	7.8134	2.67852	2.09644	1498.5	178701
228484	109215352	21.8632	7.8188	2.67943	2.09205	1501.7	179451
229441	109902239	21.8861	7.8243	2.68034	2.08768	1504.8	180203
230400	110592000	21.9089	7.8297	2.68124	2.08333	1508.0	180956
231361	111284641	21.9317	7.8352	2.68215	2.07900	1511.1	181711
232324	111980168	21.9545	7.8406	2.68305	2.07469	1514.3	182467
233289	112678587	21.9773	7.8460	2.68395	2.07039	1517.4	183225
234256	113379904	22.0000	7.8514	2.68485	2.06612	1520.5	183984
235225	114084125	22.0227	7.8568	2.68574	2.06186	1523.7	184745
236196	114791256	22.0454	7.8622	2.68664	2.05761	1526.8	185508
237169	115501303	22.0681	7.8676	2.68753	2.05339	1530.0	186272
238144	116214272	22.0907	7.8730	2.68842	2.04918	1533.1	187038
239121	116930169	22.1133	7.8784	2.68931	2.04499	1536.2	187805
240100	117649000	22.1359	7.8837	2.69020	2.04082	1539.4	188574
241081	118370771	22.1585	7.8891	2.69108	2.03666	1542.5	189345
242064	119095488	22.1811	7.8944	2.69197	2.03252	1545.7	190117
243049	119823157	22.2036	7.8998	2.69285	2.02840	1548.8	190890
244036	120553784	22.2261	7.9051	2.69373	2.02429	1551.9	191665
245025	121287375	22.2486	7.9105	2.69461	2.02020	1555.1	192442
246016	122023936	22.2711	7.9158	2.69548	2.01613	1558.2	193221
247009	122763473	22.2935	7.9211	2.69636	2.01207	1561.4	194000
248004	123505992	22.3159	7.9264	2.69723	2.00803	1564.5	194782
249001	124251499	22.3383	7.9317	2.69810	2.00401	1567.7	[illegible]

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS,
CIRCUMFERENCES AND CIRCULAR AREAS OF NOS. FROM

No.	Square	Cube	Sq. Root	Cu. Root	Log.	1000xRecip.
500	250000	125000000	22.3607	7.9370	2.69897	2.00000
501	251001	125751501	22.3830	7.9423	2.69984	1.99601
502	252004	126506008	22.4054	7.9476	2.70070	1.99203
503	253009	127263527	22.4277	7.9528	2.70157	1.98807
504	254016	128024064	22.4499	7.9581	2.70243	1.98413
505	255025	128787625	22.4722	7.9634	2.70329	1.98020
506	256036	129554216	22.4944	7.9686	2.70415	1.97629
507	257049	130323843	22.5167	7.9739	2.70501	1.97239
508	258064	131096512	22.5389	7.9791	2.70586	1.96850
509	259081	131872229	22.5610	7.9843	2.70672	1.96464
510	260100	132651000	22.5832	7.9896	2.70757	1.96078
511	261121	133432831	22.6053	7.9948	2.70842	1.95695
512	262144	134217728	22.6274	8.0000	2.70927	1.95312
513	263169	135005697	22.6495	8.0052	2.71012	1.94932
514	264196	135796744	22.6716	8.0104	2.71096	1.94553
515	265225	136590875	22.6936	8.0156	2.71181	1.94175
516	266256	137388096	22.7156	8.0208	2.71265	1.93798
517	267289	138188413	22.7376	8.0260	2.71349	1.93424
518	268324	138991832	22.7596	8.0311	2.71433	1.93050
519	269361	139798359	22.7816	8.0363	2.71517	1.92678
520	270400	140608000	22.8035	8.0415	2.71600	1.92308
521	271441	141420761	22.8254	8.0466	2.71684	1.91939
522	272484	142236648	22.8473	8.0517	2.71767	1.91571
523	273529	143055667	22.8692	8.0569	2.71850	1.91205
524	274576	143877824	22.8910	8.0620	2.71933	1.90840
525	275625	144703125	22.9129	8.0671	2.72016	1.90476
526	276676	145531576	22.9347	8.0723	2.72099	1.90114
527	277729	146363183	22.9565	8.0774	2.72181	1.89753
528	278784	147197952	22.9783	8.0825	2.72263	1.89394
529	279841	148035889	23.0000	8.0876	2.72346	1.89036
530	280900	148877000	23.0217	8.0927	2.72428	1.88679
531	281961	149721291	23.0434	8.0978	2.72509	1.88324
532	283024	150568768	23.0651	8.1028	2.72591	1.87970
533	284089	151419437	23.0868	8.1079	2.72673	1.87617
534	285156	152273304	23.1084	8.1130	2.72754	1.87266
535	286225	153130375	23.1301	8.1180	2.72835	1.86916
536	287296	153990656	23.1517	8.1231	2.72916	1.86567
537	288369	154854153	23.1733	8.1281	2.72997	1.86220
538	289444	155720872	23.1948	8.1332	2.73078	1.85874
539	290521	156590819	23.2164	8.1382	2.73159	1.85529
540	291600	157464000	23.2379	8.1433	2.73239	1.85185
541	292681	158340421	23.2594	8.1483	2.73320	1.84843
542	293764	159220088	23.2809	8.1533	2.73400	1.84502
543	294849	160103007	23.3024	8.1583	2.73480	1.84162
544	295936	160989184	23.3238	8.1633	2.73560	1.83824
545	297025	161878625	23.3452	8.1683	2.73640	1.83486
546	298116	162771336	23.3666	8.1733	2.73719	1.83150
547	299209	163667323	23.3880	8.1783	2.73799	1.82815
548	300304	164566592	23.4094	8.1833	2.73878	1.82482
549	301401	165469149	23.4307	8.1882	2.73957	1.82149

UBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, RECIPROCALS, MFERENCES AND CIRCULAR AREAS OF NOS. FROM 1 TO 1000

Cube	Sq. Root	Cu. Root	Log.	1000×Recip.	No. = Dia.	
					Circum.	Area
166375000	23.4521	8.1932	2.74036	1.81818	1727.9	237583
167284151	23.4734	8.1982	2.74115	1.81488	1731.0	238448
168196608	23.4947	8.2031	2.74194	1.81159	1734.2	239314
169112377	23.5160	8.2081	2.74273	1.80832	1737.3	240182
170031464	23.5372	8.2130	2.74351	1.80505	1740.4	241051
170953875	23.5584	8.2180	2.74429	1.80180	1743.6	241922
171879616	23.5797	8.2229	2.74507	1.79856	1746.7	242795
172808693	23.6008	8.2278	2.74586	1.79533	1749.9	243669
173741112	23.6220	8.2327	2.74663	1.79211	1753.0	244545
174676879	23.6432	8.2377	2.74741	1.78891	1756.2	245422
175616000	23.6643	8.2426	2.74819	1.78571	1759.3	246301
176558481	23.6854	8.2475	2.74896	1.78253	1762.4	247181
177504328	23.7065	8.2524	2.74974	1.77936	1765.6	248063
178453547	23.7276	8.2573	2.75051	1.77620	1768.7	248947
179406144	23.7487	8.2621	2.75128	1.77305	1771.9	249832
180362125	23.7697	8.2670	2.75205	1.76991	1775.0	250719
181321496	23.7908	8.2719	2.75282	1.76678	1778.1	251607
182284263	23.8118	8.2768	2.75358	1.76367	1781.3	252497
183250432	23.8328	8.2816	2.75435	1.76056	1784.4	253388
184220009	23.8537	8.2865	2.75511	1.75747	1787.6	254281
185193000	23.8747	8.2913	2.75587	1.75439	1790.7	255176
186169411	23.8956	8.2962	2.75664	1.75131	1793.9	256072
187149248	23.9165	8.3010	2.75740	1.74825	1797.0	256970
188132517	23.9374	8.3059	2.75815	1.74520	1800.1	257869
189119224	23.9583	8.3107	2.75891	1.74216	1803.3	258770
190109375	23.9792	8.3155	2.75967	1.73913	1806.4	259672
191102976	24.0000	8.3203	2.76042	1.73611	1809.6	260576
192100033	24.0208	8.3251	2.76118	1.73310	1812.7	261482
193100552	24.0416	8.3300	2.76193	1.73010	1815.8	262389
194104539	24.0624	8.3348	2.76268	1.72712	1819.0	263298
195112000	24.0832	8.3396	2.76343	1.72414	1822.1	264208
196122941	24.1039	8.3443	2.76418	1.72117	1825.3	265120
197137368	24.1247	8.3491	2.76492	1.71821	1828.4	266033
198155287	24.1454	8.3539	2.76567	1.71527	1831.6	266948
199176704	24.1661	8.3587	2.76641	1.71233	1834.7	267865
200201625	24.1868	8.3634	2.76716	1.70940	1837.8	268783
201230056	24.2074	8.3682	2.76790	1.70649	1841.0	269701
202262003	24.2281	8.3730	2.76864	1.70358	1844.1	270624
203297472	24.2487	8.3777	2.76938	1.70068	1847.3	271547
204336469	24.2693	8.3825	2.77012	1.69779	1850.4	272471
205379000	24.2899	8.3872	2.77085	1.69492	1853.5	273397
206425071	24.3105	8.3919	2.77159	1.69205	1856.7	274325
207474688	24.3311	8.3967	2 77232	1.68919	1859.8	275254
208527857	24.3516	8.4014	2.77305	1.68634	1863.0	276184
209584584	24.3721	8.4061	2.77379	1.68350	1866.1	277117
210644875	24.3926	8.4108	2.77452	1.68067	1869.3	278051
211708736	24.4131	8.4155	2.77525	1.67785	1872.4	278986
212776173	24.4336	8.4202	2.77597	1.67504	1875.5	279922
213847192	24.4540	8.4249	2.77670	1.67224	1878.7	[illegible]
214921799	24.4745	8.4296	2.77743	1.66945	1881.8	[illegible]

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, R
CIRCUMFERENCES AND CIRCULAR AREAS OF NOS. FROM 1

No.	Square	Cube	Sq. Root	Cu. Root	Log.	1000×Recip.
600	360000	216000000	24.4949	8.4343	2.77815	1.66667
601	361201	217081801	24.5153	8.4390	2.77887	1.66389
602	362404	218167208	24.5357	8.4437	2.77960	1.66113
603	363609	219256227	24.5561	8.4484	2.78032	1.65837
604	364816	220348864	24.5764	8.4530	2.78104	1.65563
605	366025	221445125	24.5967	8.4577	2.78176	1.65289
606	367236	222545016	24.6171	8.4623	2.78247	1.65017
607	368449	223648543	24.6374	8.4670	2.78319	1.64745
608	369664	224755712	24.6577	8.4716	2.78390	1.64474
609	370881	225866529	24.6779	8.4763	2.78462	1.64204
610	372100	226981000	24.6982	8.4809	2.78533	1.63934
611	373321	228099131	24.7184	8.4856	2.78604	1.63666
612	374544	229220928	24.7386	8.4902	2.78675	1.63399
613	375769	230346397	24.7588	8.4948	2.78746	1.63132
614	376996	231475544	24.7790	8.4994	2.78817	1.62866
615	378225	232608375	24.7992	8.5040	2.78888	1.62602
616	379456	233744896	24.8193	8.5086	2.78958	1.62338
617	380689	234885113	24.8395	8.5132	2.79029	1.62075
618	381924	236029032	24.8596	8.5178	2.79099	1.61812
619	383161	237176659	24.8797	8.5224	2.79169	1.61551
620	384400	238328000	24.8998	8.5270	2.79239	1.61290
621	385641	239483061	24.9199	8.5316	2.79309	1.61031
622	386884	240641848	24.9399	8.5362	2.79379	1.60772
623	388129	241804367	24.9600	8.5408	2.79449	1.60514
624	389376	242970624	24.9800	8.5453	2.79518	1.60256
625	390625	244140625	25.0000	8.5499	2.79588	1.60000
626	391876	245314376	25.0200	8.5544	2.79657	1.59744
627	393129	246491883	25.0400	8.5590	2.79727	1.59490
628	394384	247673152	25.0599	8.5635	2.79796	1.59236
629	395641	248858189	25.0799	8.5681	2.79865	1.58983
630	396900	250047000	25.0998	8.5726	2.79934	1.58730
631	398161	251239591	25.1197	8.5772	2.80003	1.58479
632	399424	252435968	25.1396	8.5817	2.80072	1.58228
633	400689	253636137	25.1595	8.5862	2.80140	1.57978
634	401956	254840104	25.1794	8.5907	2.80209	1.57729
635	403225	256047875	25.1992	8.5952	2.80277	1.57480
636	404496	257259456	25.2190	8.5997	2.80346	1.57233
637	405769	258474853	25.2389	8.6043	2.80414	1.56986
638	407044	259694072	25.2587	8.6088	2.80482	1.56740
639	408321	260917119	25.2784	8.6132	2.80550	1.56495
640	409600	262144000	25.2982	8.6177	2.80618	1.56250
641	410881	263374721	25.3180	8.6222	2.80686	1.56006
642	412164	264609288	25.3377	8.6267	2.80754	1.55763
643	413449	265847707	25.3574	8.6312	2.80821	1.55521
644	414736	267089984	25.3772	8.6357	2.80889	1.55280
645	416025	268336125	25.3969	8.6401	2.80956	1.55039
646	417316	269586136	25.4165	8.6446	2.81023	1.54799
647	418609	270840023	25.4362	8.6490	2.81090	1.54560
648	419904	272097792	25.4558	8.6535	2.81158	1.54321
649	421201	273359449	25.4755	8.6579	2.81224	1.54083

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, RECIPROCALS, CIRCUMFERENCES AND CIRCULAR AREAS OF NOS. FROM 1 TO 1000

No.	Square	Cube	Sq. Root	Cu. Root	Log.	1000xRecip.	No. = Dia.	
							Circum.	Area
650	422500	274625000	25.4951	8.6624	2.81291	1.53846	2042.0	331831
651	423801	275894451	25.5147	8.6668	2.81358	1.53610	2045.2	332853
652	425104	277167808	25.5343	8.6713	2.81425	1.53374	2048.3	333876
653	426409	278445077	25.5539	8.6757	2.81491	1.53139	2051.5	334901
654	427716	279726264	25.5734	8.6801	2.81558	1.52905	2054.6	335927
655	429025	281011375	25.5930	8.6845	2.81624	1.52672	2057.7	336955
656	430336	282300416	25.6125	8.6890	2.81690	1.52439	2060.9	337985
657	431649	283593393	25.6320	8.6934	2.81757	1.52207	2064.0	339016
658	432964	284890312	25.6515	8.6978	2.81823	1.51976	2067.2	340049
659	434281	286191179	25.6710	8.7022	2.81889	1.51745	2070.3	341084
660	435600	287496000	25.6905	8.7066	2.81954	1.51515	2073.5	342119
661	436921	288804781	25.7099	8.7110	2.82020	1.51286	2076.6	343157
662	438244	290117528	25.7294	8.7154	2.82086	1.51057	2079.7	344196
663	439569	291434247	25.7488	8.7198	2.82151	1.50830	2082.9	345237
664	440896	292754944	25.7682	8.7241	2.82217	1.50602	2086.0	346279
665	442225	294079625	25.7876	8.7285	2.82282	1.50376	2089.2	347323
666	443556	295408296	25.8070	8.7329	2.82347	1.50150	2092.3	348368
667	444889	296740963	25.8263	8.7373	2.82413	1.49925	2095.4	349415
668	446224	298077632	25.8457	8.7416	2.82478	1.49701	2098.6	350464
669	447561	299418309	25.8650	8.7460	2.82543	1.49477	2101.7	351514
670	448900	300763000	25.8844	8.7503	2.82607	1.49254	2104.9	352565
671	450241	302111711	25.9037	8.7547	2.82672	1.49031	2108.0	353618
672	451584	303464448	25.9230	8.7590	2.82737	1.48810	2111.2	354673
673	452929	304821217	25.9422	8.7634	2.82802	1.48588	2114.3	355730
674	454276	306182024	25.9615	8.7677	2.82866	1.48368	2117.4	356788
675	455625	307546875	25.9808	8.7721	2.82930	1.48148	2120.6	357847
676	456976	308915776	26.0000	8.7764	2.82995	1.47929	2123.7	358908
677	458329	310288733	26.0192	8.7807	2.83059	1.47711	2126.9	359971
678	459684	311665752	26.0384	8.7850	2.83123	1.47493	2130.0	361035
679	461041	313046839	26.0576	8.7893	2.83187	1.47275	2133.1	362101
680	462400	314432000	26.0768	8.7937	2.83251	1.47059	2136.3	363168
681	463761	315821241	26.0960	8.7980	2.83315	1.46843	2139.4	364237
682	465124	317214568	26.1151	8.8023	2.83378	1.46628	2142.6	365308
683	466489	318611987	26.1343	8.8066	2.83442	1.46413	2145.7	366380
684	467856	320013504	26.1534	8.8109	2.83506	1.46199	2148.9	367453
685	469225	321419125	26.1725	8.8152	2.83569	1.45985	2152.0	368528
686	470596	322828856	26.1916	8.8194	2.83632	1.45773	2155.1	369605
687	471969	324242703	26.2107	8.8237	2.83696	1.45560	2158.3	370684
688	473344	325660672	26.2298	8.8280	2.83759	1.45349	2161.4	371764
689	474721	327082769	26.2488	8.8323	2.83822	1.45138	2164.6	372845
690	476100	328509000	26.2679	8.8366	2.83885	1.44928	2167.7	373928
691	477481	329939371	26.2869	8.8408	2.83948	1.44718	2170.8	375013
692	478864	331373888	26.3059	8.8451	2.84011	1.44509	2174.0	376099
693	480249	332812557	26.3249	8.8493	2.84073	1.44300	2177.1	377187
694	481636	334255384	26.3439	8.8536	2.84136	1.44092	2180.3	378276
695	483025	335702375	26.3629	8.8578	2.84198	1.43885	2183.4	379367
696	484416	337153536	26.3818	8.8621	2.84261	1.43678	2186.6	380459
697	485809	338608873	26.4008	8.8663	2.84323	1.43472	2189.7	381554
698	487204	340068392	26.4197	8.8706	2.84386	1.43267	2192.8	[illegible]
699	488601	341532099	26.4386	8.8748	2.84448	1.43062	2196.0	[illegible]

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS
CIRCUMFERENCES AND CIRCULAR AREAS OF NOS. FRO

No.	Square	Cube	Sq. Root	Cu. Root	Log.	1000xRecip.
700	490000	343000000	26.4575	8.8790	2.84510	1.42857
701	491401	344472101	26.4764	8.8833	2.84572	1.42653
702	492804	345948408	26.4953	8.8875	2.84634	1.42450
703	494209	347428927	26.5141	8.8917	2.84696	1.42248
704	495616	348913664	26.5330	8.8959	2.84757	1.42046
705	497025	350402625	26.5518	8.9001	2.84819	1.41844
706	498436	351895816	26.5707	8.9043	2.84880	1.41643
707	499849	353393243	26.5895	8.9085	2.84942	1.41443
708	501264	354894912	26.6083	8.9127	2.85003	1.41243
709	502681	356400829	26.6271	8.9169	2.85065	1.41044
710	504100	357911000	26.6458	8.9211	2.85126	1.40845
711	505521	359425431	26.6646	8.9253	2.85187	1.40647
712	506944	360944128	26.6833	8.9295	2.85248	1.40449
713	508369	362467097	26.7021	8.9337	2.85309	1.40253
714	509796	363994344	26.7208	8.9378	2.85370	1.40056
715	511225	365525875	26.7395	8.9420	2.85431	1.39860
716	512656	367061696	26.7582	8.9462	2.85491	1.39665
717	514089	368601813	26.7769	8.9503	2.85552	1.39470
718	515524	370146232	26.7955	8.9545	2.85612	1.39276
719	516961	371694959	26.8142	8.9587	2.85673	1.39082
720	518400	373248000	26.8328	8.9628	2.85733	1.38889
721	519841	374805361	26.8514	8.9670	2.85794	1.38696
722	521284	376367048	26.8701	8.9711	2.85854	1.38504
723	522729	377933067	26.8887	8.9752	2.85914	1.38313
724	524176	379503424	26.9072	8.9794	2.85974	1.38122
725	525625	381078125	26.9258	8.9835	2.86034	1.37931
726	527076	382657176	26.9444	8.9876	2.86094	1.37741
727	528529	384240583	26.9629	8.9918	2.86153	1.37552
728	529984	385828352	26.9815	8.9959	2.86213	1.37363
729	531441	387420489	27.0000	9.0000	2.86273	1.37174
730	532900	389017000	27.0185	9.0041	2.86332	1.36986
731	534361	390617891	27.0370	9.0082	2.86392	1.36799
732	535824	392223168	27.0555	9.0123	2.86451	1.36612
733	537289	393832837	27.0740	9.0164	2.86510	1.36426
734	538756	395446904	27.0924	9.0205	2.86570	1.36240
735	540225	397065375	27.1109	9.0246	2.86629	1.36054
736	541696	398688256	27.1293	9.0287	2.86688	1.35870
737	543169	400315553	27.1477	9.0328	2.86747	1.35685
738	544644	401947272	27.1662	9.0369	2.86806	1.35501
739	546121	403583419	27.1846	9.0410	2.86864	1.35318
740	547600	405224000	27.2029	9.0450	2.86923	1.35135
741	549081	406869021	27.2213	9.0491	2.86982	1.34953
742	550564	408518488	27.2397	9.0532	2.87040	1.34771
743	552049	410172407	27.2580	9.0572	2.87099	1.34590
744	553536	411830784	27.2764	9.0613	2.87157	1.34409
745	555025	413493625	27.2947	9.0654	2.87216	1.34228
746	556516	415160936	27.3130	9.0694	2.87274	1.34048
747	558009	416832723	27.3313	9.0735	2.87332	1.33869
748	559504	418508992	27.3496	9.0775	2.87390	1.33690
749	561001	420189749	27.3679	9.0816	2.87448	1.33511

UBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, RECIPROCALS, MFERENCES AND CIRCULAR AREAS OF NOS. FROM 1 TO 1000

Cube	Sq. Root	Cu. Root	Log.	1000×Recip.	No. = Dia.	
					Circum.	Area
421875000	27.3861	9.0856	2.87506	1.33333	2356.2	441786
423564751	27.4044	9.0896	2.87564	1.33156	2359.3	442965
425259008	27.4226	9.0937	2.87622	1.32979	2362.5	444146
426957777	27.4408	9.0977	2.87680	1.32802	2365.6	445328
428661064	27.4591	9.1017	2.87737	1.32626	2368.8	446511
430368875	27.4773	9.1057	2.87795	1.32450	2371.9	447697
432081216	27.4955	9.1098	2.87852	1.32275	2375.0	448883
433798093	27.5136	9.1138	2.87910	1.32100	2378.2	450072
435519512	27.5318	9.1178	2.87967	1.31926	2381.3	451262
437245479	27.5500	9.1218	2.88024	1.31752	2384.5	452453
438976000	27.5681	9.1258	2.88081	1.31579	2387.6	453646
440711081	27.5862	9.1298	2.88138	1.31406	2390.8	454841
442450728	27.6043	9.1338	2.88196	1.31234	2393.9	456037
444194947	27.6225	9.1378	2.88252	1.31062	2397.0	457234
445943744	27.6405	9.1418	2.88309	1.30890	2400.2	458434
447697125	27.6586	9.1458	2.88366	1.30719	2403.3	459635
449455096	27.6767	9.1498	2.88423	1.30548	2406.5	460837
451217663	27.6948	9.1537	2.88480	1.30378	2409.6	462042
452984832	27.7128	9.1577	2.88536	1.30208	2412.7	463247
454756609	27.7308	9.1617	2.88593	1.30039	2415.9	464454
456533000	27.7489	9.1657	2.88649	1.29870	2419.0	465663
458314011	27.7669	9.1696	2.88705	1.29702	2422.2	466873
460099648	27.7849	9.1736	2.88762	1.29534	2425.3	468085
461889917	27.8029	9.1775	2.88818	1.29366	2428.5	469298
463684824	27.8209	9.1815	2.88874	1.29199	2431.6	470513
465484375	27.8388	9.1855	2.88930	1.29032	2434.7	471730
467288576	27.8568	9.1894	2.88986	1.28866	2437.9	472948
469097433	27.8747	9.1933	2.89042	1.28700	2441.0	474168
470910952	27.8927	9.1973	2.89098	1.28535	2444.2	475389
472729139	27.9106	9.2012	2.89154	1.28370	2447.3	476612
474552000	27.9285	9.2052	2.89209	1.28205	2450.4	477836
476379541	27.9464	9.2091	2.89265	1.28041	2453.6	479062
478211768	27.9643	9.2130	2.89321	1.27877	2456.7	480290
480048687	27.9821	9.2170	2.89376	1.27714	2459.9	481519
481890304	28.0000	9.2209	2.89432	1.27551	2463.0	482750
483736625	28.0179	9.2248	2.89487	1.27389	2466.2	483982
485587656	28.0357	9.2287	2.89542	1.27226	2469.3	485216
487443403	28.0535	9.2326	2.89597	1.27065	2472.4	486451
489303872	28.0713	9.2365	2.89653	1.26904	2475.6	487688
491169069	28.0891	9.2404	2.89708	1.26743	2478.7	488927
493039000	28.1069	9.2443	2.89763	1.26582	2481.9	490167
494913671	28.1247	9.2482	2.89818	1.26422	2485.0	491409
496793088	28.1425	9.2521	2.89873	1.26263	2488.1	492652
498677257	28.1603	9.2560	2.89927	1.26103	2491.3	493897
500566184	28.1780	9.2599	2.89982	1.25945	2494.4	495143
502459875	28.1957	9.2638	2.90037	1.25786	2497.6	496391
504358336	28.2135	9.2677	2.90091	1.25628	2500.7	497641
506261573	28.2312	9.2716	2.90146	1.25471	2503.8	498892
508169592	28.2489	9.2754	2.90200	1.25313	2507.0	500145
510082399	28.2666	9.2793	2.90255	1.25156	2510.1	501399

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, RECIPR
CIRCUMFERENCES AND CIRCULAR AREAS OF NOS. FROM 1 TO 100

No.	Square	Cube	Sq. Root	Cu. Root	Log.	1000xRecip.	No. =
							Circum.
800	640000	512000000	28.2843	9.2832	2.90309	1.25000	2513.3
801	641601	513922401	28.3019	9.2870	2.90363	1.24844	2516.4
802	643204	515849608	28.3196	9.2909	2.90417	1.24688	2519.6
803	644809	517781627	28.3373	9.2948	2.90472	1.24533	2522.7
804	646416	519718464	28.3549	9.2986	2.90526	1.24378	2525.8
805	648025	521660125	28.3725	9.3025	2.90580	1.24224	2529.0
806	649636	523606616	28.3901	9.3063	2.90634	1.24069	2532.1
807	651249	525557943	28.4077	9.3102	2.90687	1.23916	2535.3
808	652864	527514112	28.4253	9.3140	2.90741	1.23762	2538.4
809	654481	529475129	28.4429	9.3179	2.90795	1.23609	2541.5
810	656100	531441000	28.4605	9.3217	2.90849	1.23457	2544.7
811	657721	533411731	28.4781	9.3255	2.90902	1.23305	2547.8
812	659344	535387328	28.4956	9.3294	2.90956	1.23153	2551.0
813	660969	537367797	28.5132	9.3332	2.91009	1.23001	2554.1
814	662596	539353144	28.5307	9.3370	2.91062	1.22850	2557.3
815	664225	541343375	28.5482	9.3408	2.91116	1.22699	2560.4
816	665856	543338496	28.5657	9.3447	2.91169	1.22549	2563.5
817	667489	545338513	28.5832	9.3485	2.91222	1.22399	2566.7
818	669124	547343432	28.6007	9.3523	2.91275	1.22249	2569.8
819	670761	549353259	28.6182	9.3561	2.91328	1.22100	2573.0
820	672400	551368000	28.6356	9.3599	2.91381	1.21951	2576.1
821	674041	553387661	28.6531	9.3637	2.91434	1.21803	2579.2
822	675684	555412248	28.6705	9.3675	2.91487	1.21655	2582.4
823	677329	557441767	28.6880	9.3713	2.91540	1.21507	2585.5
824	678976	559476224	28.7054	9.3751	2.91593	1.21359	2588.7
825	680625	561515625	28.7228	9.3789	2.91645	1.21212	2591.8
826	682276	563559976	28.7402	9.3827	2.91698	1.21065	2595.0
827	683929	565609283	28.7576	9.3865	2.91751	1.20919	2598.1
828	685584	567663552	28.7750	9.3902	2.91803	1.20773	2601.2
829	687241	569722789	28.7924	9.3940	2.91855	1.20627	2604.4
830	688900	571787000	28.8097	9.3978	2.91908	1.20482	2607.5
831	690561	573856191	28.8271	9.4016	2.91960	1.20337	2610.7
832	692224	575930368	28.8444	9.4053	2.92012	1.20192	2613.8
833	693889	578009537	28.8617	9.4091	2.92065	1.20048	2616.9
834	695556	580093704	28.8791	9.4129	2.92117	1.19904	2620.1
835	697225	582182875	28.8964	9.4166	2.92169	1.19760	2623.2
836	698896	584277056	28.9137	9.4204	2.92221	1.19617	2626.4
837	700569	586376253	28.9310	9.4241	2.92273	1.19474	2629.5
838	702244	588480472	28.9482	9.4279	2.92324	1.19332	2632.7
839	703921	590589719	28.9655	9.4316	2.92376	1.19189	2635.8
840	705600	592704000	28.9828	9.4354	2.92428	1.19048	2638.9
841	707281	594823321	29.0000	9.4391	2.92480	1.18906	2642.1
842	708964	596947688	29.0172	9.4429	2.92531	1.18765	2645.2
843	710649	599077107	29.0345	9.4466	2.92583	1.18624	2648.4
844	712336	601211584	29.0517	9.4503	2.92634	1.18483	2651.5
845	714025	603351125	29.0689	9.4541	2.92686	1.18343	2654.6
846	715716	605495736	29.0861	9.4578	2.92737	1.18203	2657.8
847	717409	607645423	29.1033	9.4615	2.92788	1.18064	2660.9
848	719104	609800192	29.1204	9.4652	2.92840	1.17925	2664.1
849	720801	611960049	29.1376	9.4690	2.92891	1.17786	2667.2

[S]ARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, RECIPROCALS, CIRCUMFERENCES AND CIRCULAR AREAS OF NOS. FROM 1 TO 1000

Square	Cube	Sq. Root	Cu. Root	Log.	1000xRecip.	No. = Dia.	
						Circum.	Area
722500	614125000	29.1548	9.4727	2.92942	1.17647	2670.4	567450
724201	616295051	29.1719	9.4764	2.92993	1.17509	2673.5	568786
725904	618470208	29.1890	9.4801	2.93044	1.17371	2676.6	570124
727609	620650477	29.2062	9.4838	2.93095	1.17233	2679.8	571463
729316	622835864	29.2233	9.4875	2.93146	1.17096	2682.9	572803
731025	625026375	29.2404	9.4912	2.93197	1.16959	2686.1	574146
732736	627222016	29.2575	9.4949	2.93247	1.16822	2689.2	575490
734449	629422793	29.2746	9.4986	2.93298	1.16686	2692.3	576835
736164	631628712	29.2916	9.5023	2.93349	1.16550	2695.5	578182
737881	633839779	29.3087	9.5060	2.93399	1.16414	2698.6	579530
739600	636056000	29.3258	9.5097	2.93450	1.16279	2701.8	580880
741321	638277381	29.3428	9.5134	2.93500	1.16144	2704.9	582232
743044	640503928	29.3598	9.5171	2.93551	1.16009	2708.1	583585
744769	642735647	29.3769	9.5207	2.93601	1.15875	2711.2	584940
746496	644972544	29.3939	9.5244	2.93651	1.15741	2714.3	586297
748225	647214625	29.4109	9.5281	2.93702	1.15607	2717.5	587655
749956	649461896	29.4279	9.5317	2.93752	1.15473	2720.6	589014
751689	651714363	29.4449	9.5354	2.93802	1.15340	2723.8	590375
753424	653972032	29.4618	9.5391	2.93852	1.15207	2726.9	591738
755161	656234909	29.4788	9.5427	2.93902	1.15075	2730.0	593102
756900	658503000	29.4958	9.5464	2.93952	1.14943	2733.2	594468
758641	660776311	29.5127	9.5501	2.94002	1.14811	2736.3	595835
760384	663054848	29.5296	9.5537	2.94052	1.14679	2739.5	597204
762129	665338617	29.5466	9.5574	2.94101	1.14548	2742.6	598575
763876	667627624	29.5635	9.5610	2.94151	1.14416	2745.8	599947
765625	669921875	29.5804	9.5647	2.94201	1.14286	2748.9	601320
767376	672221376	29.5973	9.5683	2.94250	1.14155	2752.0	602696
769129	674526133	29.6142	9.5719	2.94300	1.14025	2755.2	604073
770884	676836152	29.6311	9.5756	2.94349	1.13895	2758.3	605451
772641	679151439	29.6479	9.5792	2.94399	1.13766	2761.5	606831
774400	681472000	29.6648	9.5828	2.94448	1.13636	2764.6	608212
776161	683797841	29.6816	9.5865	2.94498	1.13507	2767.7	609595
777924	686128968	29.6985	9.5901	2.94547	1.13379	2770.9	610980
779689	688465387	29.7153	9.5937	2.94596	1.13250	2774.0	612366
781456	690807104	29.7321	9.5973	2.94645	1.13122	2777.2	613754
783225	693154125	29.7489	9.6010	2.94694	1.12994	2780.3	615143
784996	695506456	29.7658	9.6046	2.94743	1.12867	2783.5	616534
786769	697864103	29.7825	9.6082	2.94792	1.12740	2786.6	617927
788544	700227072	29.7993	9.6118	2.94841	1.12613	2789.7	619321
790321	702595369	29.8161	9.6154	2.94890	1.12486	2792.9	620717
792100	704969000	29.8329	9.6190	2.94939	1.12360	2796.0	622114
793881	707347971	29.8496	9.6226	2.94988	1.12233	2799.2	623513
795664	709732288	29.8664	9.6262	2.95036	1.12108	2802.3	624913
797449	712121957	29.8831	9.6298	2.95085	1.11982	2805.4	626315
799236	714516984	29.8998	9.6334	2.95134	1.11857	2808.6	627718
801025	716917375	29.9166	9.6370	2.95182	1.11732	2811.7	629124
802816	719323136	29.9333	9.6406	2.95231	1.11607	2814.9	630530
804609	721734273	29.9500	9.6442	2.95279	1.11483	2818.0	631938
806404	724150792	29.9666	9.6477	2.95328	1.11359	2821.2	633348
808201	726572699	29.9833	9.6513	2.95376	1.11235	2824.3	634760

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, RECIPROCA
CIRCUMFERENCES AND CIRCULAR AREAS OF NOS. FROM 1 TO 1000

No.	Square	Cube	Sq. Root	Cu. Root	Log.	1000×Recip.	No. = Dia.	
							Circum.	Ar
900	810000	729000000	30.0000	9.6549	2.95424	1.11111	2827.4	63
901	811801	731432701	30.0167	9.6585	2.95472	1.10988	2830.6	63
902	813604	733870808	30.0333	9.6620	2.95521	1.10865	2833.7	63
903	815409	736314327	30.0500	9.6656	2.95569	1.10742	2836.9	64
904	817216	738763264	30.0666	9.6692	2.95617	1.10619	2840.0	64
905	819025	741217625	30.0832	9.6727	2.95665	1.10497	2843.1	64
906	820836	743677416	30.0998	9.6763	2.95713	1.10375	2846.3	64
907	822649	746142643	30.1164	9.6799	2.95761	1.10254	2849.4	64
908	824464	748613312	30.1330	9.6834	2.95809	1.10132	2852.6	64
909	826281	751089429	30.1496	9.6870	2.95856	1.10011	2855.7	64
910	828100	753571000	30.1662	9.6905	2.95904	1.09890	2858.8	65
911	829921	756058031	30.1828	9.6941	2.95952	1.09769	2862.0	65
912	831744	758550528	30.1993	9.6976	2.95999	1.09649	2865.1	65
913	833569	761048497	30.2159	9.7012	2.96047	1.09529	2868.3	65
914	835396	763551944	30.2324	9.7047	2.96095	1.09409	2871.4	65
915	837225	766060875	30.2490	9.7082	2.96142	1.09290	2874.6	65
916	839056	768575296	30.2655	9.7118	2.96190	1.09170	2877.7	65
917	840889	771095213	30.2820	9.7153	2.96237	1.09051	2880.8	66
918	842724	773620632	30.2985	9.7188	2.96284	1.08932	2884.0	66
919	844561	776151559	30.3150	9.7224	2.96332	1.08814	2887.1	66
920	846400	778688000	30.3315	9.7259	2.96379	1.08696	2890.3	66
921	848241	781229961	30.3480	9.7294	2.96426	1.08578	2893.4	66
922	850084	783777448	30.3645	9.7329	2.96473	1.08460	2896.5	66
923	851929	786330467	30.3809	9.7364	2.96520	1.08342	2899.7	66
924	853776	788889024	30.3974	9.7400	2.96567	1.08225	2902.8	67
925	855625	791453125	30.4138	9.7435	2.96614	1.08108	2906.0	67
926	857476	794022776	30.4302	9.7470	2.96661	1.07991	2909.1	67
927	859329	796597983	30.4467	9.7505	2.96708	1.07875	2912.3	67
928	861184	799178752	30.4631	9.7540	2.96755	1.07759	2915.4	67
929	863041	801765089	30.4795	9.7575	2.96802	1.07643	2918.5	67
930	864900	804357000	30.4959	9.7610	2.96848	1.07527	2921.7	67
931	866761	806954491	30.5123	9.7645	2.96895	1.07411	2924.8	6
932	868624	809557568	30.5287	9.7680	2.96942	1.07296	2928.0	6
933	870489	812166237	30.5450	9.7715	2.96988	1.07181	2931.1	6
934	872356	814780504	30.5614	9.7750	2.97035	1.07066	2934.2	6
935	874225	817400375	30.5778	9.7785	2.97081	1.06952	2937.4	6
936	876096	820025856	30.5941	9.7819	2.97128	1.06838	2940.5	6
937	877969	822656953	30.6105	9.7854	2.97174	1.06724	2943.7	6
938	879844	825293672	30.6268	9.7889	2.97220	1.06610	2946.8	6
939	881721	827936019	30.6431	9.7924	2.97267	1.06496	2950.0	6
940	883600	830584000	30.6594	9.7959	2.97313	1.06383	2953.1	6
941	885481	833237621	30.6757	9.7993	2.97359	1.06270	2956.2	6
942	887364	835896888	30.6920	9.8028	2.97405	1.06157	2959.4	6
943	889249	838561807	30.7083	9.8063	2.97451	1.06045	2962.5	6
944	891136	841232384	30.7246	9.8097	2.97497	1.05932	2965.7	6
945	893025	843908625	30.7409	9.8132	2.97543	1.05820	2968.8	7
946	894916	846590536	30.7571	9.8167	2.97589	1.05708	2971.9	7
947	896809	849278123	30.7734	9.8201	2.97635	1.05597	2975.1	7
948	898704	851971392	30.7896	9.8236	2.97681	1.05485	2978.2	7
949	900601	854670349	30.8058	9.8270	2.97727	1.05374	2981.4	7

CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, RECIPROCALS, MFERENCES AND CIRCULAR AREAS OF NOS. FROM 1 TO 1000

e	Cube	Sq. Root	Cu. Root	Log.	1000×Recip.	No. = Dia.	
						Circum.	Area
0	857375000	30.8221	9.8305	2.97772	1.05263	2984.5	708822
1	860085351	30.8383	9.8339	2.97818	1.05152	2987.7	710315
4	862801408	30.8545	9.8374	2.97864	1.05042	2990.8	711809
9	865523177	30.8707	9.8408	2.97909	1.04932	2993.9	713306
6	868250664	30.8869	9.8443	2.97955	1.04822	2997.1	714803
5	870983875	30.9031	9.8477	2.98000	1.04712	3000.2	716303
6	873722816	30.9192	9.8511	2.98046	1.04603	3003.4	717804
9	876467493	30.9354	9.8546	2.98091	1.04493	3006.5	719306
4	879217912	30.9516	9.8580	2.98137	1.04384	3009.6	720810
1	881974079	30.9677	9.8614	2.98182	1.04275	3012.8	722316
0	884736000	30.9839	9.8648	2.98227	1.04167	3015.9	723823
1	887503681	31.0000	9.8683	2.98272	1.04058	3019.1	725332
4	890277128	31.0161	9.8717	2.98318	1.03950	3022.2	726842
9	893056347	31.0322	9.8751	2.98363	1.03842	3025.4	728354
6	895841344	31.0483	9.8785	2.98408	1.03734	3028.5	729867
5	898632125	31.0644	9.8819	2.98453	1.03627	3031.6	731382
6	901428696	31.0805	9.8854	2.98498	1.03520	3034.8	732899
9	904231063	31.0966	9.8888	2.98543	1.03413	3037.9	734417
4	907039232	31.1127	9.8922	2.98588	1.03306	3041.1	735937
1	909853209	31.1288	9.8956	2.98632	1.03199	3044.2	737458
0	912673000	31.1448	9.8990	2.98677	1.03093	3047.3	738981
1	915498611	31.1609	9.9024	2.98722	1.02987	3050.5	740506
4	918330048	31.1769	9.9058	2.98767	1.02881	3053.6	742032
9	921167317	31.1929	9.9092	2.98811	1.02775	3056.8	743559
6	924010424	31.2090	9.9126	2.98856	1.02669	3059.9	745088
5	926859375	31.2250	9.9160	2.98900	1.02564	3063.1	746619
6	929714176	31.2410	9.9194	2.98945	1.02459	3066.2	748151
9	932574833	31.2570	9.9227	2.98989	1.02354	3069.3	749685
4	935441352	31.2730	9.9261	2.99034	1.02249	3072.5	751221
1	938313739	31.2890	9.9295	2.99078	1.02145	3075.6	752758
0	941192000	31.3050	9.9329	2.99123	1.02041	3078.8	754296
1	944076141	31.3209	9.9363	2.99167	1.01937	3081.9	755837
4	946966168	31.3369	9.9396	2.99211	1.01833	3085.0	757378
9	949862087	31.3528	9.9430	2.99255	1.01729	3088.2	758922
6	952763904	31.3688	9.9464	2.99300	1.01626	3091.3	760466
5	955671625	31.3847	9.9497	2.99344	1.01523	3094.5	762013
6	958585256	31.4006	9.9531	2.99388	1.01420	3097.6	763561
9	961504803	31.4166	9.9565	2.99432	1.01317	3100.8	765111
4	964430272	31.4325	9.9598	2.99476	1.01215	3103.9	766662
1	967361669	31.4484	9.9632	2.99520	1.01112	3107.0	768214
0	970299000	31.4643	9.9666	2.99564	1.01010	3110.2	769769
1	973242271	31.4802	9.9699	2.99607	1.00908	3113.3	771325
4	976191488	31.4960	9.9733	2.99651	1.00806	3116.5	772882
9	979146657	31.5119	9.9766	2.99695	1.00705	3119.6	774441
6	982107784	31.5278	9.9800	2.99739	1.00604	3122.7	776002
5	985074875	31.5436	9.9833	2.99782	1.00503	3125.9	777564
6	988047936	31.5595	9.9866	2.99826	1.00402	3129.0	779128
9	991026973	31.5753	9.9900	2.99870	1.00301	3132.2	780693
4	994011992	31.5911	9.9933	2.99913	1.00200	3135.3	782260
1	997002999	31.6070	9.9967	2.99957	1.00100	3138.5	783828

Degrees	TANGENT					
	0′	10′	20′	30′	40′	50′
0	0.00000	0.00291	0.00582	0.00873	0.01164	0.01455
1	0.01746	0.02036	0.02328	0.02619	0.02910	0.03201
2	0.03492	0.03783	0.04075	0.04366	0.04658	0.04949
3	0.05241	0.05533	0.05824	0.06116	0.06408	0.06700
4	0.06993	0.07285	0.07578	0.07870	0.08163	0.08456
5	0.08749	0.09042	0.09335	0.09629	0.09923	0.10216
6	0.10510	0.10805	0.11099	0.11394	0.11688	0.11983
7	0.12278	0.12574	0.12869	0.13165	0.13461	0.13758
8	0.14054	0.14351	0.14648	0.14945	0.15243	0.15540
9	0.15838	0.16137	0.16435	0.16734	0.17033	0.17333
10	0.17633	0.17933	0.18233	0.18534	0.18835	0.19136
11	0.19438	0.19740	0.20042	0.20345	0.20648	0.20952
12	0.21256	0.21560	0.21864	0.22169	0.22475	0.22781
13	0.23087	0.23393	0.23700	0.24008	0.24316	0.24624
14	0.24933	0.25242	0.25552	0.25862	0.26172	0.26483
15	0.26795	0.27107	0.27419	0.27732	0.28046	0.28360
16	0.28675	0.28990	0.29305	0.29621	0.29938	0.30255
17	0.30573	0.30891	0.31210	0.31530	0.31850	0.32171
18	0.32492	0.32814	0.33136	0.33460	0.33783	0.34108
19	0.34433	0.34758	0.35085	0.35412	0.35740	0.36068
20	0.36397	0.36727	0.37057	0.37388	0.37720	0.38053
21	0.38386	0.38721	0.39055	0.39391	0.39727	0.40065
22	0.40403	0.40741	0.41081	0.41421	0.41763	0.42105
23	0.42447	0.42791	0.43136	0.43481	0.43828	0.44175
24	0.44523	0.44872	0.45222	0.45573	0.45924	0.46277
25	0.46631	0.46985	0.47341	0.47698	0.48055	0.48414
26	0.48773	0.49134	0.49495	0.49858	0.50222	0.50587
27	0.50953	0.51320	0.51688	0.52057	0.52427	0.52798
28	0.53171	0.53545	0.53920	0.54296	0.54674	0.55051
29	0.55431	0.55812	0.56194	0.56577	0.56962	0.57348
30	0.57735	0.58124	0.58513	0.58905	0.59297	0.59691
31	0.60086	0.60483	0.60881	0.61280	0.61681	0.62083
32	0.62487	0.62892	0.63299	0.63707	0.64117	0.64528
33	0.64941	0.65355	0.65771	0.66189	0.66608	0.67028
34	0.67451	0.67875	0.68301	0.68728	0.69157	0.69588
35	0.70021	0.70455	0.70891	0.71329	0.71769	0.72211
36	0.72654	0.73100	0.73547	0.73996	0.74447	0.74900
37	0.75355	0.75812	0.76272	0.76733	0.77196	0.77661
38	0.78129	0.78598	0.79070	0.79544	0.80020	0.80498
39	0.80978	0.81461	0.81946	0.82434	0.82923	0.83415
40	0.83910	0.84407	0.84906	0.85408	0.85912	0.86419
41	0.86929	0.87441	0.87955	0.88473	0.88992	0.89515
42	0.90040	0.90569	0.91099	0.91633	0.92170	0.92709
43	0.93252	0.93797	0.94345	0.94896	0.95451	0.96008
44	0.96569	0.97133	0.97700	0.98270	0.98843	0.99420
	60′	50′	40′	30′	20′	10′
	COTANGENT					

Degrees	COTANGENT 0′	10′	20′	30′	40′	50′	60′	
0	∞	343.77371	171.88540	114.58865	85.93979	68.75009	57.28996	89
1	57.28996	49.10388	42.96408	38.18846	34.36777	31.24158	28.63625	88
2	28.63625	26.43160	24.54176	22.90377	21.47040	20.20555	19.08114	87
3	19.08114	18.07498	17.16934	16.34986	15.60478	14.92442	14.30067	86
4	14.30067	13.72674	13.19688	12.70621	12.25051	11.82617	11.43005	85
5	11.43005	11.05943	10.71191	10.38540	10.07803	9.78817	9.51436	84
6	9.51436	9.25530	9.00983	8.77689	8.55555	8.34496	8.14435	83
7	8.14435	7.95302	7.77035	7.59575	7.42871	7.26873	7.11537	82
8	7.11537	6.96823	6.82694	6.69116	6.56055	6.43484	6.31375	81
9	6.31375	6.19703	6.08444	5.97576	5.87080	5.76937	5.67128	80
10	5.67128	5.57638	5.48451	5.39552	5.30928	5.22566	5.14455	79
11	5.14455	5.06584	4.98940	4.91516	4.84300	4.77286	4.70463	78
12	4.70463	4.63825	4.57363	4.51071	4.44942	4.38969	4.33148	77
13	4.33148	4.27471	4.21933	4.16530	4.11256	4.06107	4.01078	76
14	4.01078	3.96165	3.91364	3.86671	3.82083	3.77595	3.73205	75
15	3.73205	3.68909	3.64705	3.60588	3.56557	3.52609	3.48741	74
16	3.48741	3.44951	3.41236	3.37594	3.34023	3.30521	3.27085	73
17	3.27085	3.23714	3.20406	3.17159	3.13972	3.10842	3.07768	72
18	3.07768	3.04749	3.01783	2.98869	2.96004	2.93189	2.90421	71
19	2.90421	2.87700	2.85023	2.82391	2.79802	2.77254	2.74748	70
20	2.74748	2.72281	2.69853	2.67462	2.65109	2.62791	2.60509	69
21	2.60509	2.58261	2.56046	2.53865	2.51715	2.49597	2.47509	68
22	2.47509	2.45451	2.43422	2.41421	2.39449	2.37504	2.35585	67
23	2.35585	2.33693	2.31826	2.29984	2.28167	2.26374	2.24604	66
24	2.24604	2.22857	2.21132	2.19430	2.17749	2.16090	2.14451	65
25	2.14451	2.12832	2.11233	2.09654	2.08094	2.06553	2.05030	64
26	2.05030	2.03526	2.02039	2.00569	1.99116	1.97680	1.96261	63
27	1.96261	1.94858	1.93470	1.92098	1.90741	1.89400	1.88073	62
28	1.88073	1.86760	1.85462	1.84177	1.82907	1.81649	1.80405	61
29	1.80405	1.79174	1.77955	1.76749	1.75556	1.74375	1.73205	60
30	1.73205	1.72047	1.70901	1.69766	1.68643	1.67530	1.66428	59
31	1.66428	1.65337	1.64256	1.63185	1.62125	1.61074	1.60033	58
32	1.60033	1.59002	1.57981	1.56969	1.55966	1.54972	1.53987	57
33	1.53987	1.53010	1.52043	1.51084	1.50133	1.49190	1.48256	56
34	1.48256	1.47330	1.46411	1.45501	1.44598	1.43703	1.42815	55
35	1.42815	1.41934	1.41061	1.40195	1.39336	1.38484	1.37638	54
36	1.37638	1.36800	1.35968	1.35142	1.34323	1.33511	1.32704	53
37	1.32704	1.31904	1.31110	1.30323	1.29541	1.28764	1.27994	52
38	1.27994	1.27230	1.26471	1.25717	1.24969	1.24227	1.23490	51
39	1.23490	1.22758	1.22031	1.21310	1.20593	1.19882	1.19175	50
40	1.19175	1.18474	1.17777	1.17085	1.16398	1.15715	1.15037	49
41	1.15037	1.14363	1.13694	1.13029	1.12369	1.11713	1.11061	48
42	1.11061	1.10414	1.09770	1.09131	1.08496	1.07864	1.07237	47
43	1.07237	1.06613	1.05994	1.05378	1.04766	1.04158	1.03553	46
44	1.03553	1.02952	1.02355	1.01761	1.01170	1.00583	1.00000	45
	60′	50′	40′	30′	20′	10′	0′	Degrees
	TANGENT							

Degrees	SINE.						
	0′	10′	20′	30′	40′	50′	60′
0	0.00000	0.00291	0.00582	0.00873	0.01164	0.01454	0.01745
1	0.01745	0.02036	0.02327	0.02618	0.02908	0.03199	0.03490
2	0.03490	0.03781	0.04071	0.04362	0.04653	0.04943	0.05234
3	0.05234	0.05524	0.05814	0.06105	0.06395	0.06685	0.06976
4	0.06976	0.07266	0.07556	0.07846	0.08136	0.08426	0.08716
5	0.08716	0.09005	0.09295	0.09585	0.09874	0.10164	0.10453
6	0.10453	0.10742	0.11031	0.11320	0.11609	0.11898	0.12187
7	0.12187	0.12476	0.12764	0.13053	0.13341	0.13629	0.13917
8	0.13917	0.14205	0.14493	0 14781	0.15069	0.15356	0.15643
9	0.15643	0.15931	0.16218	0.16505	0.16792	0.17078	0.17365
10	0.17365	0.17651	0.17937	0.18224	0.18500	0.18795	0.19081
11	0.19081	0.19366	0.19652	0.19937	0.20222	0.20507	0.20791
12	0.20791	0.21076	0.21360	0.21644	0.21928	0.22212	0.22495
13	0.22495	0.22778	0.23062	0.23345	0.23627	0.23910	0.24192
14	0.24192	0.24474	0.24756	0.25038	0.25320	0.25601	0.25882
15	0.25882	0.26163	0.26443	0.26724	0.27004	0.27284	0.27564
16	0.27564	0.27843	0.28123	0.28402	0.28680	0.28959	0.29237
17	0.29237	0.29515	0.29793	0.30071	0.30348	0.30625	0.30902
18	0.30902	0.31178	0.31454	0.31730	0.32006	0.32282	0.32557
19	0.32557	0.32832	0.33106	0.33381	0.33655	0.33929	0.34202
20	0.34202	0.34475	0.34748	0.35021	0.35293	0.35565	0.35837
21	0.35837	0.36108	0.36379	0.36650	0.36921	0.37191	0.37461
22	0.37461	0.37730	0.37999	0.38268	0.38537	0.38805	0.39073
23	0.39073	0.39341	0.39608	0.39875	0.40142	0.40408	0.40674
24	0.40674	0.40939	0.41204	0.41469	0.41734	0.41998	0.42262
25	0.42262	0.42525	0.42788	0.43051	0.43318	0.43575	0.43837
26	0.43837	0.44098	0.44359	0.44620	0.44880	0.45140	0.45399
27	0.45399	0.45658	0.45917	0.46175	0.46433	0.46690	0.46947
28	0.46947	0.47204	0.47460	0.47716	0.47971	0.48226	0.48481
29	0.48481	0.48735	0.48989	0.49242	0.49495	0.49748	0.50000
30	0.50000	0.50252	0.50503	0.50754	0.51004	0.51254	0.51504
31	0.51504	0.51753	0.52002	0.52250	0.52498	0.52745	0.52992
32	0.52992	0.53238	0.53484	0.53730	0.53975	0.54220	0.54464
33	0.54464	0.54708	0.54951	0.55194	0.55436	0.55678	0.55919
34	0.55919	0.56160	0.56401	0.56641	0.56880	0.57119	0.57358
35	0.57358	0.57596	0.57833	0.58070	0.58307	0.58543	0.58779
36	0.58779	0.59014	0.59248	0.59482	0.59716	0.59949	0.60182
37	0.60182	0.60414	0.60645	0.60876	0.61107	0.61337	0.61566
38	0.61566	0.61795	0.62024	0.62251	0.62479	0.62706	0.62932
39	0.62932	0.63158	0.63383	0.63608	0.63832	0.64056	0.64279
40	0.64279	0.64501	0.64723	0.64945	0.65166	0.65386	0.65606
41	0.65606	0.65825	0.66044	0.66262	0.66480	0.66697	0.66913
42	0.66913	0.67129	0.67344	0.67559	0.67773	0.67987	0.68200
43	0.68200	0.68412	0.68624	0.68835	0 69046	0.69256	0.69466
44	0.69466	0.69675	0.69883	0.70091	0.70298	0.70505	0.70711
	60′	50′	40′	30′	20′	10′	0′
	COSINE.						

Degrees	COSINE.							
	0′	10′	20′	30′	40′	50′	60′	
0	1.00000	1.00000	0.99998	0.99996	0.99993	0.99989	0.99985	89
1	0.99985	0.99979	0.99973	0.99966	0.99958	0.99949	0.99939	88
2	0.99939	0.99929	0.99917	0.99905	0.99892	0.99878	0.99863	87
3	0.99863	0.99847	0.99831	0.99813	0.99795	0.99776	0.99756	86
4	0.99756	0.99736	0.99714	0.99692	0.99668	0.99644	0.99619	85
5	0.99619	0.99594	0.99567	0.99540	0.99511	0.99482	0.99452	84
6	0.99452	0.99421	0.99390	0.99357	0.99324	0.99290	0.99255	83
7	0.99255	0.99219	0.99182	0.99144	0.99106	0.99067	0.99027	82
8	0.99027	0.98986	0.98944	0.98902	0.98858	0.98814	0.98769	81
9	0.98769	0 98723	0.98676	0.98629	0.98580	0.98531	0.98481	80
10	0.98481	0.98430	0.98378	0.98325	0.98272	0.98218	0.98163	79
11	0.98163	0.98107	0.98050	0.97992	0.97934	0.97875	0.97815	78
12	0.97815	0.97754	0.97692	0.97630	0.97566	0.97502	0.97437	77
13	0.97437	0.97371	0.97304	0.97237	0.97169	0.97100	0.97030	76
14	0.97030	0.96959	0.96887	0.96815	0.96742	0.96667	0.96593	75
15	0.96593	0.96517	0.96440	0.96363	0.96285	0.90206	0.96126	74
16	0.96126	0.96046	0.95964	0.95882	0.95799	0.95715	0.95630	73
17	0.95630	0.95545	0.95459	0.95372	0.95284	0.95195	0.95106	72
18	0.95106	0.95015	0.94924	0.94832	0.94740	0.94646	0.94552	71
19	0.94552	0.94457	0.94361	0.94264	0.94167	0.94068	0.93969	70
20	0.93969	0.93869	0.93769	0.93667	0.93565	0.93462	0.93358	69
21	0.93358	0.93253	0.93148	0.93042	0.92935	0.92827	0.92718	68
22	0.92718	0.92609	0.92499	0.92388	0.92276	0.92164	0.92050	67
23	0.92050	0.91936	0.91822	0.91706	0.91590	0.91472	0.91355	66
24	0.91355	0.91236	0.91116	0.90996	0.90875	0.90753	0.90631	65
25	0.90631	0.90507	0.90383	0.90259	0.90133	0.90007	0.89879	64
26	0.89879	0.89752	0.89623	0.89493	0.89363	0.89232	0.89101	63
27	0.89101	0.88968	0.88835	0.88701	0.88566	0.88431	0.88295	62
28	0.88295	0 88158	0.88020	0.87882	0.87743	0.87603	0.87462	61
29	0.87462	0.87321	0.87178	0.87036	0.86892	0.86748	0.86603	60
30	0.86603	0.86457	0.86310	0.86163	0.86015	0.85866	0.85717	59
31	0.85717	0.85567	0.85416	0.85264	0.85112	0.84959	0.84805	58
32	0.84805	0.84650	0.84495	0.84339	0.84182	0.84025	0.83867	57
33	0.83867	0.83708	0.83549	0.83389	0.83228	0.83066	0.82904	56
34	0.82904	0.82741	0.82577	0.82413	0.82248	0.82082	0.81915	55
35	0.81915	0.81748	0.81580	0.81412	0.81242	0.81072	0.80902	54
36	0.80902	0.80730	0.80558	0.80386	0.80212	0.80038	0.79864	53
37	0.79864	0.79688	0.79512	0.79335	0.79158	0.78980	0.78801	52
38	0.78801	0.78622	0.78442	0.78261	0.78079	0.77897	0.77715	51
39	0.77715	0.77531	0.77347	0.77162	0.76977	0.76791	0.76604	50
40	0.76604	0.76417	0.76229	0.76041	0.75851	0.75661	0.75471	49
41	0.75471	0.75280	0.75088	0.74896	0.74703	0.74509	0.74314	48
42	0.74314	0.74120	0.73924	0.73728	0.73531	0.73333	0.73135	47
43	0.73135	0.72937	0.72737	0.72537	0.72337	0.72136	0.71934	46
44	0.71934	0.71732	0.71529	0.71325	0.71121	0.70916	0.70711	45
	60′	50′	40′	30′	20′	10′	0′	Degrees
	SINE.							

SECANTS

Degrees	0′	10′	20′	30′	40′	50′	60′	
0	1.00000	1.00001	1.00002	1.00004	1.00007	1.00011	1.00015	89
1	1.00015	1.00021	1.00027	1.00034	1.00042	1.00051	1.00061	88
2	1.00061	1.00072	1.00083	1.00095	1.00108	1.00122	1.00137	87
3	1.00137	1.00153	1.00169	1.00187	1.00205	1.00224	1.00244	86
4	1.00244	1.00265	1.00287	1.00309	1.00333	1.00357	1.00382	85
5	1.00382	1.00408	1.00435	1.00463	1.00491	1.00521	1.00551	84
6	1.00551	1.00582	1.00614	1.00647	1.00681	1.00715	1.00751	83
7	1.00751	1.00787	1.00825	1.00863	1.00902	1.00942	1.00983	82
8	1.00983	1.01024	1.01067	1.01111	1.01155	1.01200	1.01247	81
9	1.01247	1.01294	1.01342	1.01391	1.01440	1.01491	1.01543	80
10	1.01543	1.01595	1.01649	1.01703	1.01758	1.01815	1.01872	79
11	1.01872	1.00930	1.01989	1.02049	1.02110	1.02171	1.02234	78
12	1.02234	1.02298	1.02362	1.02428	1.02494	1.02562	1.02630	77
13	1.02630	1.02700	1.02770	1.02842	1.02914	1.02987	1.03061	76
14	1.03061	1.03137	1.03213	1.03290	1.03368	1.03447	1.03528	75
15	1.03528	1.03609	1.03691	1.03774	1.03858	1.03944	1.04030	74
16	1.04030	1.04117	1.04206	1.04295	1.04385	1.04477	1.04569	73
17	1.04569	1.04663	1.04757	1.04853	1.04950	1.05047	1.05146	72
18	1.05146	1.05246	1.05347	1.05449	1.05552	1.05657	1.05762	71
19	1.05762	1.05869	1.05976	1.06085	1.06195	1.06306	1.06418	70
20	1.06418	1.06531	1.06645	1.06761	1.06878	1.06995	1.07115	69
21	1.07115	1.07235	1.07356	1.07479	1.07602	1.07727	1.07853	68
22	1.07853	1.07981	1.08109	1.08239	1.08370	1.08503	1.08636	67
23	1.08636	1.08771	1.08907	1.09044	1.09183	1.09323	1.09464	66
24	1.09464	1.09606	1.09750	1.09895	1.10041	1.10189	1.10338	65
25	1.10338	1.10488	1.10640	1.10793	1.10947	1.11103	1.11260	64
26	1.11260	1.11419	1.11579	1.11740	1.11903	1.12067	1.12233	63
27	1.12233	1.12400	1.12568	1.12738	1.12910	1.13083	1.13257	62
28	1.13257	1.13433	1.13610	1.13789	1.13970	1.14152	1.14335	61
29	1.14335	1.14521	1.14707	1.14896	1.15085	1.15277	1.15470	60
30	1.15470	1.15665	1.15861	1.16059	1.16259	1.16460	1.16663	59
31	1.16663	1.16868	1.17075	1.17283	1.17493	1.17704	1.17918	58
32	1.17918	1.18133	1.18350	1.18569	1.18790	1.19012	1.19236	57
33	1.19236	1.19463	1.19691	1.19920	1.20152	1.20386	1.20622	56
34	1.20622	1.20859	1.21099	1.21341	1.21584	1.21830	1.22077	55
35	1.22077	1.22327	1.22579	1.22833	1.23089	1.23347	1.23607	54
36	1.23607	1.23869	1.24134	1.24400	1.24669	1.24940	1.25214	53
37	1.25214	1.25489	1.25767	1.26047	1.26330	1.26615	1.26902	52
38	1.26902	1.27191	1.27483	1.27778	1.28075	1.28374	1.28676	51
39	1.28676	1.28980	1.29287	1.29597	1.29909	1.30223	1.30541	50
40	1.30541	1.30861	1.31183	1.31509	1.31837	1.32168	1.32501	49
41	1.32501	1.32838	1.33177	1.33519	1.33864	1.34212	1.34563	48
42	1.34563	1.34917	1.35274	1.35634	1.35997	1.36363	1.36733	47
43	1.36733	1.37105	1.37481	1.37860	1.38242	1.38628	1.39016	46
44	1.39016	1.39409	1.39804	1.40203	1.40606	1.41012	1.41421	45
	60′	50′	40′	30′	20′	10′	0′	Degrees

COSECANTS

Degrees	COSECANTS							
	0′	10′	20′	30′	40′	50′	60′	
0	∞	343.77516	171.88831	114.59301	85.94561	68.75736	57.29869	89
1	57.29869	49.11406	42.97571	38.20155	34.38232	31.25758	28.65371	88
2	28.65371	26.45051	24.56212	22.92559	21.49368	20.23028	19.10732	87
3	19.10732	18.10262	17.19843	16.38041	15.63679	14.95788	14.33559	86
4	14.33559	13.76312	13.23472	12.74550	12.29125	11.86837	11.47371	85
5	11.47371	11.10455	10.75849	10.43343	10.12752	9.83912	9.56677	84
6	9.56677	9.30917	9.06515	8.83367	8.61379	8.46466	8.20551	83
7	8.20551	8.01565	7.83443	7.66130	7.49571	7.33719	7.18530	82
8	7.18530	7.03962	6.89979	6.76547	6.63633	6.51208	6.39245	81
9	6.39245	6.27719	6.16607	6.05886	5.95536	5.85539	5.75877	80
10	5.75877	5.66533	5.57493	5.48740	5.40263	5.32049	5.24084	79
11	5.24084	5.16359	5.08863	5.01585	4.94517	4.87649	4.80973	78
12	4.80973	4.74482	4.68167	4.62023	4.56041	4.50216	4.44541	77
13	4.44541	4.39012	4.33622	4.28366	4.23239	4.18238	4.13357	76
14	4.13357	4.08591	4.03938	3.99393	3.94952	3.90613	3.86370	75
15	3.86370	3.82223	3.78166	3.74198	3.70315	3.66515	3.62796	74
16	3.62796	3.59154	3.55587	3.52094	3.48671	3.45317	3.42030	73
17	3.42030	3.38808	3.35649	3.32551	3.29512	3.26531	3.23607	72
18	3.23607	3.20737	3.17920	3.15155	3.12440	3.09774	3.07155	71
19	3.07155	3.04584	3.02057	2.99574	2 97135	2.94737	2.92380	70
20	2.92380	2.90063	2.87785	2.85545	2.83342	2.81175	2.79043	69
21	2.79043	2.76945	2.74881	2.72850	2.70851	2.68884	2.66947	68
22	2.66947	2.65040	2.63162	2.61313	2.59491	2.57698	2.55930	67
23	2.55930	2.54190	2.52474	2.50784	2.49119	2.47477	2.45859	66
24	2.45859	2.44264	2.42692	2.41142	2.39614	2.38107	2.36620	65
25	2.36620	2.35154	2.33708	2.32282	2.30875	2.29487	2.28117	64
26	2.28117	2.26766	2.25432	2.24116	2.22817	2.21535	2.20269	63
27	2.20269	2.19019	2.17786	2.16568	2.15366	2.14178	2.13005	62
28	2.13005	2.11847	2.10704	2.09574	2.08458	2.07356	2.06267	61
29	2.06267	2.05191	2.04128	2.03077	2.02039	2.01014	2.00000	60
30	2.00000	1.98998	1.98008	1.97029	1.96062	1.95106	1.94160	59
31	1.94160	1.93226	1.92302	1.91388	1.90485	1.89591	1.88709	58
32	1.88708	1.87834	1.86990	1.86116	1.85271	1.84435	1.83608	57
33	1.83608	1.82790	1.81981	1.81180	1.80388	1.79604	1.78829	56
34	1.78829	1.78062	1.77303	1 76552	1.75808	1.75073	1.74345	55
35	1.74345	1.73624	1.72911	1.72205	1.71506	1.70815	1.70130	54
36	1.70130	1.69452	1.68782	1.68117	1.67460	1.66809	1.66164	53
37	1.66164	1.65526	1.64894	1.64268	1.63648	1.63035	1.62427	52
38	1.62427	1.61825	1.61229	1.60639	1.60054	1.59475	1.58902	51
39	1.58902	1.58333	1.57771	1.57213	1.56661	1.56114	1.55572	50
40	1.55572	1.55036	1.54504	1.53977	1.53455	1.52938	1.52425	49
41	1.52425	1.51918	1.51415	1.50916	1.50422	1.49933	1.49448	48
42	1.49448	1.48967	1.48491	1.48019	1.47551	1.47087	1.46628	47
43	1.46628	1.46173	1.45721	1.45274	1.44831	1.44391	1.43956	46
44	1.43956	1.43524	1.43096	1.42672	1.42251	1.41835	1.41421	45
	60′	50′	40′	30′	20′	10′	0′	Degrees
	SECANTS							

Carnegie Steel Comp

Manufacturer of

Bessemer and Basic Open Hea
Steel of all Grades

Owns and operates the following

Edgar Thomson Furnaces . . .	Besse
Duquesne Furnaces	Duqu
Lucy Furnaces	Pittsb
Carrie Furnaces	Ranki
Edgar Thomson Steel Works . .	Besse
Duquesne Steel Works . . .	Duqu
Homestead Steel Works . . .	Munh
Upper Union Mills	Pittsb
Lower Union Mills	Pittsb
Howard Axle Works	Home

AT WHICH ARE PRODUCED

r Plate
s (1½ in. up), Blooms, Slabs
Manganese, Spiegel-eisen, Pig Iron
ngs, such as Axles, Arch Bars, and other Car Forgings, onnecting Rods, Crank Shafts
s for Boilers, Bridges, Ships and Tanks
Steel, 25 to 100 lbs. per yard; Steel Splice Bars (plain nd angle), for all sections of Rails
d Structural Shapes, such as Angles, Rounds, Flats, quares, Ovals, I-Beams, Channels, Tees, Zees, etc.
tural Work, such as Buildings, Girders, Columns, etc.

ADDRESS

RAL OFFICES:

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OFFICES:

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Boston; Telephone Building
Buffalo; German Insurance Building
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Cincinnati; Union Trust Building
Cleveland; Perry-Payne Building
Denver; Boston Building
Detroit; Union Trust Building
New Orleans; Hennen Building
New York; Empire Building
Philadelphia; Harrison Building
Portland; Ainsworth Block
San Francisco; 258 Market Street
St. Louis; National Bank of Commerce Building
St. Paul; Pioneer Press Building

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Montreal (Canada); Bell Telephone Building
Mexico; 924 Apartado, City of Mexico
Sydney, Australia

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